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A Welcome from the Editor

Editorial

Welcome to the very first issue of *Milvus: The Journal of the Welsh Ornithological Society*!

I hope that you will accept my apologies for the delay in producing this issue. I underestimated the timings required to produce a hard copy of a journal (my prior experiences were with journals that are electronic-only), particularly when it comes to reviewing and revising articles. I'll be working to ensure that the next issue is back on schedule and is distributed in early July. I genuinely appreciate your patience and understanding.

The new journal takes over where *Birds in Wales* left off, albeit with some important changes. We now have a web site where you can download individual articles and submit your own work for consideration We're also in the process of digitising past articles from all incarnations of the journal, making their contents available to more readers than ever before via search integration. That's a long process, of course, so volunteers who are willing to help would be more than welcome. Finally, we have an Editorial Board (see below) who will be helping grow the journal and provide guidance to potential authors.

The changes aren't intended to exclude, however. The journal is still open to - and we welcome - submissions from anyone. A summary of the new submission guidelines is available at the end of this issue and the full guidelines are available online or via email by request.

I hope you enjoy this first issue of *Milvus*. If you do have any ideas for articles, please do get in touch - we'd love to hear from you.

Best wishes,

Anthony Caravaggi

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Original Research

Movements of Jay (*Garrulus glandarius*) in Wales in autumn 2021

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Key words: Dispersal; oakmast; garden; citizen science

Abstract
Autumn 2021 saw the largest and most widespread movement of Jays recorded in Wales. This review documents these movements using citizen science data from a variety of sources and sets them in the wider context of those elsewhere in Britain and northwest Europe. The evidence suggests that the majority of Jays recorded in Wales originated from within Wales, but that birds also moved in from northwest and central/southern England. However, there was no evidence of a continental origin for the Jay movements to Britain. After aggregating at coastal headlands, islands and on the edges of large bays in Wales and having failed to find an abundance of acorns, the Jays dispersed quickly across the countryside, including into gardens where they could take advantage of supplementary food. The movements were triggered by a widespread failure of the acorn crop, synchronously across Britain, which may have been on an unprecedented scale because of particularly productive fruiting of acorns the previous autumn and clement weather that resulted in good overwinter survival of Jays and good conditions for breeding in spring 2021.

Introduction

In Britain, Jay (*Garrulus glandarius*) is a widespread and mainly sedentary species, for which 98% of ringing recoveries are within 50km of the ringing site (del Hoyo *et al.* 2009), and only one ringing record in Wales exceeds that distance (Pritchard *et al.* 2021). However, irruptions of Jay occasionally occur into and within Wales.
There is good evidence that the scale and extent of Jay movements across their range is related to the volume of fruit (acorns) produced by oak species. This oakmast forms an important component of Jay diet during autumn, and through the following winter as a result of hoarding behaviour. Jays also use these hoards to feed their young in spring (Bossema 1979). In Norway, Jay irruptions are associated with mast failure, but mast failure is not always associated with irruptions (Selås 2017). Movements there are also associated with high Jay survival over the previous winter (reduced in years of heavy snowfall in January/February, when foraging on the ground is more difficult) and a productive breeding season (when not reduced by heavy spring rainfall), resulting in an abundance of juveniles in late summer.

Autumn movements of Jay seem not to have been recorded by 19th century ornithologists in Wales (e.g. Mathew 1894, Forrest 1907). This may reflect lower abundance than today as a result of intensive control of the species by gamekeepers and lower woodland cover in the latter half of that century. There is an indication of movement in October 1947, when small numbers were seen on headlands in the far west of Pembrokeshire (Lockley *et al.* 1949). Lovegrove *et al.* (1994) referred to influxes "mainly in south Wales counties" in 1923, 1935, 1975, 1977, 1981 and 1983, and, additionally, Hurford and Lansdown (1995) mentioned 1966 as an autumn of "sizeable movements" in the Cardiff area.

The 1983 movement is the best-documented and perhaps the previous largest influx into Wales. It was most evident along the coast of East Glamorgan, between 23 September and 27 October, and Pembrokeshire from 28 September to 3 December, although John and Roskell (1985) considered that those seen in the second half of this period had arrived during October. In autumn 1983, "well over 600" bird days were recorded in Pembrokeshire, 500 in East Glamorgan and 264 in Gwent. The peak counts were made on 6 October 1983, including 200 at Martin's Haven, Pembrokeshire, which was the largest day-count at any site in Wales. The movement was evident,

in smaller numbers, farther north in Cardigan Bay, peaking with 50 at RSPB Ynys-hir, Ceredigion, on 12 October. The only Jays seen on Bardsey, Caernarfonshire, that autumn were 19 on 29 October, and elsewhere in North Wales, counts that autumn were of fewer than 10 birds, except for 15 on Pen Llŷn on 9 November.

John and Roskell (1985) showed that the 1983 Jay movement was from east to west across southern Britain, and believed that although some continental birds may have been involved, the majority were dispersing from breeding territories within Britain. Elsewhere in Europe, large southward movements from northern Fennoscandia and westward from Russia have been noted in some years, but Jays' reluctance to cross large expanses of water is illustrated by the general lack of passage recorded from the east in Kent, east Anglia, Yorkshire or eastern Scotland in such years. Records of Jay arriving off the sea at higher latitudes are rare; it is a vagrant on Shetland, for example, has yet to occur on Fair Isle, and there are no records of Jay ringed in continental Europe being recovered in Britain (or Ireland). Eastward movements of Jay out to sea are also rare in Norfolk and Kent, although not unknown in spring (e.g. Hodge 1998, Taylor *et al.* 1999). The sole ringing exchange of Jay from Britain to continental Europe was a bird ringed at Dungeness, Kent, in October 1955 that was found dead in The Netherlands in June 1956 (Robinson *et al.* 2021). In autumn 2021, with communications between birdwatchers more instantaneous than in 1983, it became clear in late September that Jay numbers were larger than usual along the southeast coast of Wales and over the following weeks, this became the largest movement ever recorded in Wales. This review investigates Jay records in Wales that autumn in order to (a) understand the spatial and temporal movements and to explain the birds' possible origin, (b) compare the movement with other years of comparable data, and to the 1983 movement, and (c) investigate the association of Jay records with oakmast data collected across Britain.

Methods

Records of three or more Jays during weeks 35-47 (30 August to 29 November 2021) were downloaded from BirdTrack and eBird on 15 January 2022, and in addition records of three or more Jays seen together were compiled from county sightings blogs/websites and Twitter and those reported directly to the author. Those downloaded from BirdTrack included records that originated on the Trektellen website of migration counts. The lower threshold of three individuals is arbitrary; it sought to avoid including resident pairs but could include family groups from which the juveniles had yet to leave the natal territory (fig. 1). Data were mapped based on the latitudinal and longitudinal points associated with each record.

For a historic perspective, all Jay records submitted to BirdTrack between 1 September and 30 November each year (dating back to 1958) were downloaded. Where the presence (but no count) of Jay was recorded in a list, this was substituted with a count of one for the analysis, and thus the results express a minimum. The comparisons with 2021 were made only with years from 2012 since this is the period in which BirdTrack has been widely used by birdwatchers across Wales.
The reporting rate and average maximum weekly count for Jays in the three autumn months (September-November) for 2011 to 2021 were downloaded from the British Trust for Ornithology Garden Birdwatch (bto.org/our-science/projects/gbw/results/long-term-patterns) on 19 December 2021.

To provide a broader geographic context, the top 100 counts in Britain for each autumn month (September-November) of 2021 submitted to the trektellen.nl website were allocated to Wales or a geographic region of England (ONS 2021). There were no Jay records from Scotland or Ireland on this website during this period. Weekly visualisations of counts submitted to national bird-recording schemes, including BirdTrack in Britain & Ireland, and produced by the European Bird Census Council website eurobirdportal.org provided a weekly snapshot of the abundance of Jay in autumn 2021 compared to the same period in previous years.

Assessments of oakmast were made using fruit scores contributed by participants to Nature's Calendar (naturescalendar.woodlandtrust.org.uk), a UK-wide citizen-science project run by the Woodland Trust during 2001-21 (accessed January 2022). This phenological project asks participants to judge the scale of the crop for a range of tree and shrub species, and score abundance as: no fruit (1), meagre (2), moderate (3), good crop (4) and exceptional (5). Data for Pedunculate Oak (*Quercus robur*) and Sessile Oak (*Q. petraea*) were analysed

to produce a mean (=average) and mode (the value that occurs most frequently) fruit score for each English region (ONS 2021), Scotland and Wales, as well as Britain as a whole. Data for Northern Ireland were excluded as there is no evidence of Jays crossing the Irish Sea during the 2021 movement. The relationship between the fruit score for each oak species and the average number of individuals per Jay record in Wales (in BirdTrack) was assessed for each year during 2012-21. The overall relationship between the number of Jays occurring in each year was compared by using Analysis of Variance. A Generalised Linear Model, with a Gamma error distribution and inverse link function, was used to identify the relationship between the number of Jays and fruiting score while testing for differences between locations (Britain or Wales). All statistical analyses were conducted in R (R Core Team 2021).

Results

Scale and geographic distribution of Jays in Wales during autumn 2021

After deduplication of records submitted to more than one source, there were 267 records of three or more Jays seen together: 128 on BirdTrack, 77 on eBird and 62 from other sources. Of these, 54% were small groups (3-5 birds), 22% were moderate

Figure. 1. Quantitative distribution of site/day counts used in the analysis. For simplicity, counts of 12-19 birds are aggregated, those of 20-99 are presented in bands of 10 and counts of 100-349 in bands of 50. These are shown in colours based on the site/day count sizes described in the text.

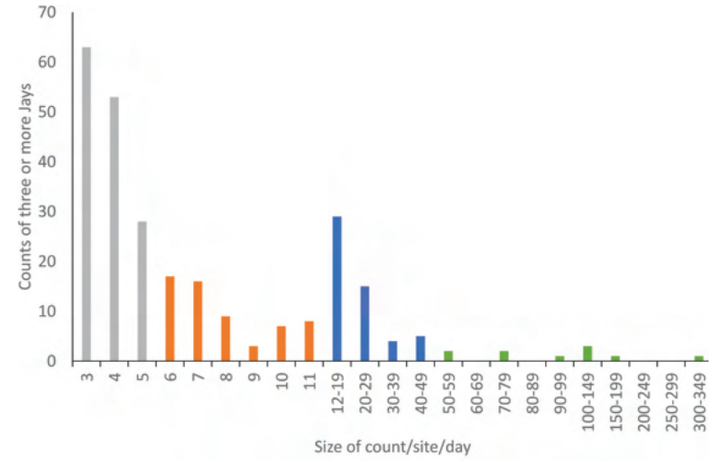


Table 1. Records of >=3 Jays and aggregated numbers by recording area.

Recording area	Records	%	Aggregated Counts	%
Gwent	26	10.2	331	10.1
E. Glamorgan	83	32.4	1411	43.1
Gower	16	6.3	169	5.2
Carmarthen	10	3.9	61	1.9
Pembroke	31	12.1	493	15.0
Ceredigion	6	2.3	96	2.9
Brecon	6	2.3	24	0.7
Radnor	1	0.4	3	0.1
Montgomery	3	1.2	14	0.4
Meirionnydd	6	2.3	35	1.1
Caernarfon	31	12.1	375	11.4
Anglesey	10	3.9	138	4.2
Denbigh	18	7.0	84	2.6
Flint	9	3.5	42	1.3

in size (6-11 birds), 20% were large groups (12-49 birds) and 4% were very large groups (>50 birds; fig. 1).

Almost half (49%) of the records of three or more Jays were from the South Wales recording areas of Gwent, East Glamorgan and Gower (table 1), 18% from West Wales (Carmarthenshire, Pembrokeshire and Ceredigion), 4% from Mid Wales (Breconshire, Radnorshire and Montgomeryshire) and 29% from North Wales (Meirionnydd, Caernarfonshire, Anglesey, Denbighshire and Flintshire). However, when the number of Jays involved in each record is incorporated to generate an aggregated count, it is evident that East Glamorgan experienced the lion's share of the movement. Collectively, the three counties in South Wales recorded over 58% of the total. North Wales (21%) and West Wales (20%) recorded similar numbers, but very few groups of three or more Jays were

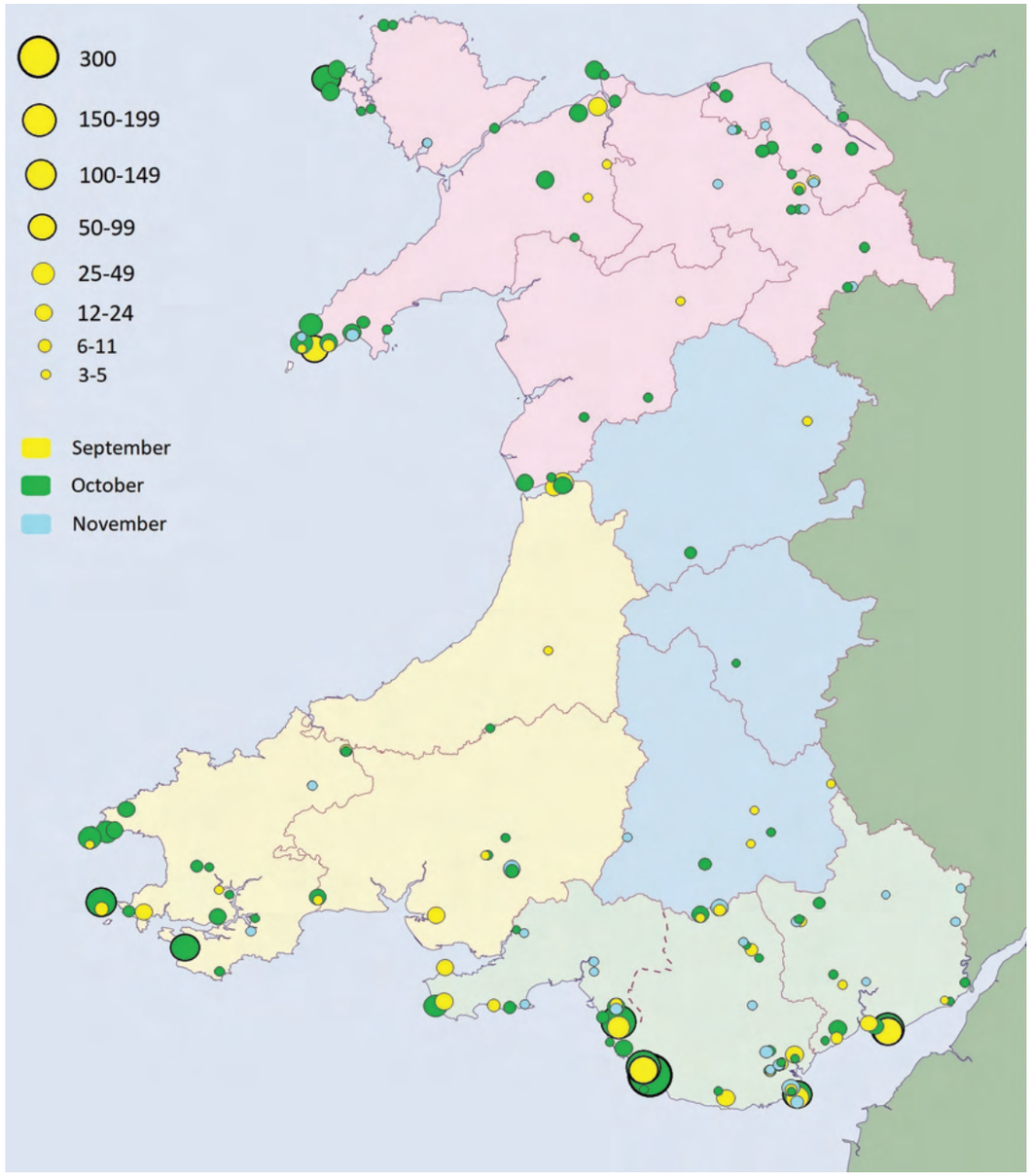


Figure. 2. Maximum count of Jay at each site recording three or more individuals, in September, October and November 2021.

seen in Mid Wales.

The map shows that a relatively small number of coastal sites accounted for a high proportion of the records (fig. 2). Of the 267 records of three or more individuals, 60% (n=159) occurred on or within 1km of the coast or a tidal estuary, and of the subset of 65 records involving 12 or more individuals, 89% (n=58) were coastal. This, at least in part, is likely to reflect the distribution of contributing birdwatchers during autumn.

All of the very large (>=50 birds) site/day counts (table 2) were at the coast. Some of these may have been a single loose flock, but most were a series of smaller groups flying in the same direction during a visit to a site lasting up to several hours. The highest site/day count of the influx, by Paul Roberts at Dunraven, East Glamorgan, on 6 October involved 300 individuals, which he described as "coasting west in flocks of 10-30" (https://twitter.com/i/web/status/1445746127647641600). The largest inland counts are shown in table 3.

The predominant direction of travel of the larger groups was westward during the peak of the movement in the second half of September and the first 10 days of October. There were a smaller number of records in which Jays were reported flying east, all of which were close to a west-facing coast, such as at Port Meudwy, Caernarfonshire, and South Stack, Anglesey, where they were seen to "u-turn" on reaching the coast (Andrew Clarke, *pers. comm.*). In Pembrokeshire, some birds flew across open water to the islands, resulting in record counts on Skomer and Ramsey of 101 and 38 respectively, on 6 October. No Jays were reported flying out to sea and none was seen on Bardsey, Caernarfonshire (where Jay had not been recorded since 18 October 1993) nor Skokholm, Pembrokeshire (where Jay has yet to be recorded).

Timing of influx

Records of Jay in the first half of September provided little inkling of what was to come, but cumulative counts in East Glamorgan of 21 and 24 birds on 15 and 16 September and then 48 on 18th indicated that movements were underway. An initial peak occurred on 26 September, with 106 in East Glamorgan and 79 in neighbouring Gwent, although 66 had been seen in Ceredigion on the previous day. There were relatively few large counts over the following week, in which there were no counts of three or more on four dates.

Three of the four days from 3 October saw the largest aggregated counts of the autumn: 173 on 3rd (including 124 in Gwent), 341 on 4th (of which 265 were in East Glamorgan) and 696 on 6th (including 359 in East Glamorgan and 293 in Pembrokeshire). The second and third of these dates fell in Week 40 (4-10 October), in which a total of 1,540 Jays was recorded in groups of three or more. That proved to be the peak week of the

Table 2. Very large counts (>=50 Jay) in Wales during autumn 2021.

Site	Recording area	Date	Count
Temple Bay, Dunraven	East Glamorgan	6 Oct.	300
Kenfig NNR	East Glamorgan	4 Oct.	161
Newport Wetlands	Gwent	3 Oct.	102
Skomer	Pembrokeshire	6 Oct.	101
Southerndown	East Glamorgan	4 Oct.	100
Castlemartin Corse	Pembrokeshire	6 Oct.	90
Newport Wetlands	Gwent	26 Sep.	76
South Stack	Anglesey	10 Oct.	72
Porth Meudwy	Caernarfonshire	9 Oct.	70
Kenfig NNR	East Glamorgan	6 Oct.	56
Lavernock Pt	East Glamorgan	26 Oct.	55
Southerndown	East Glamorgan	26 Sep.	50

influx (fig. 3). Sunday 10 October saw the third highest total of the autumn (193 across Wales), after which there was only one other date in which more than 100 Jays were counted: 109 on 16 October. Through the remainder of October and November, the average aggregate count of groups >=3 was just 11, and there were 10 dates with no counts of three or more. After Week 41, there was no aggregated weekly count >=50. Most of the higher 'bird days' in this latter period were at weekends, when more birdwatchers would be in the field. However, that was not generally the case during the peak of the influx, so it seems quite likely that a good number of other high counts went unrecorded.

A sense of Wales' place in the wider movement can be gained from visible migration counts submitted to the Trektellen.nl website. Although the number of contributors to Trektellen varies by locality, the regional differences in scale and timing of counts are evident in figure 4. The largest counts were in Wales and northwest England, whereas fewer large counts were documented in the East Midlands, Yorkshire and northeast England. The peak cumulative counts in each region were all around the same date, in Week 40. The only region with significant numbers in late September was northwest England, which may provide some clue as to the direction from which at least some birds arrived in Wales.

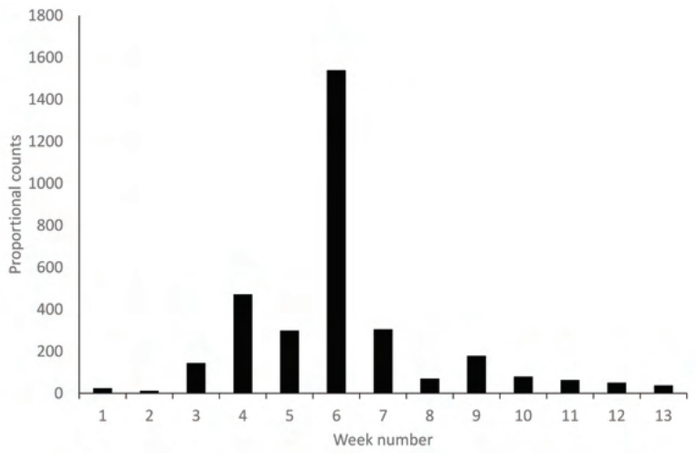


Figure. 3. Counts of Jays in Wales between weeks 35 (30 Aug.-5 Sept.) and 47 (22-28 Nov.). Week 40 is 4-10 October. Raw data can be found in Appendix 1.

Table 3. Large counts (>=12 Jay) from inland sites in Wales during autumn 2021.

Site	Recording area	Date	Count	Distance in coast (km)
Ogwen Valley	Caernarfonshire	16-Oct	23	12.6
Cosmeston Lakes CP	East Glamorgan	04-Nov	20	1.1
Cwm Cadlan NNR	East Glamorgan	10-Oct	18	29.3
Llanteg	Pembrokeshire	08-Oct	15	3
Llanishen & Lisvane Res.	East Glamorgan	24-Sep	14	5.6
Llyn Llech Owain	Carmarthenshire	15-Nov	13	16.5
Garwnant Forestry Centre	East Glamorgan	25-Nov	12	35.3

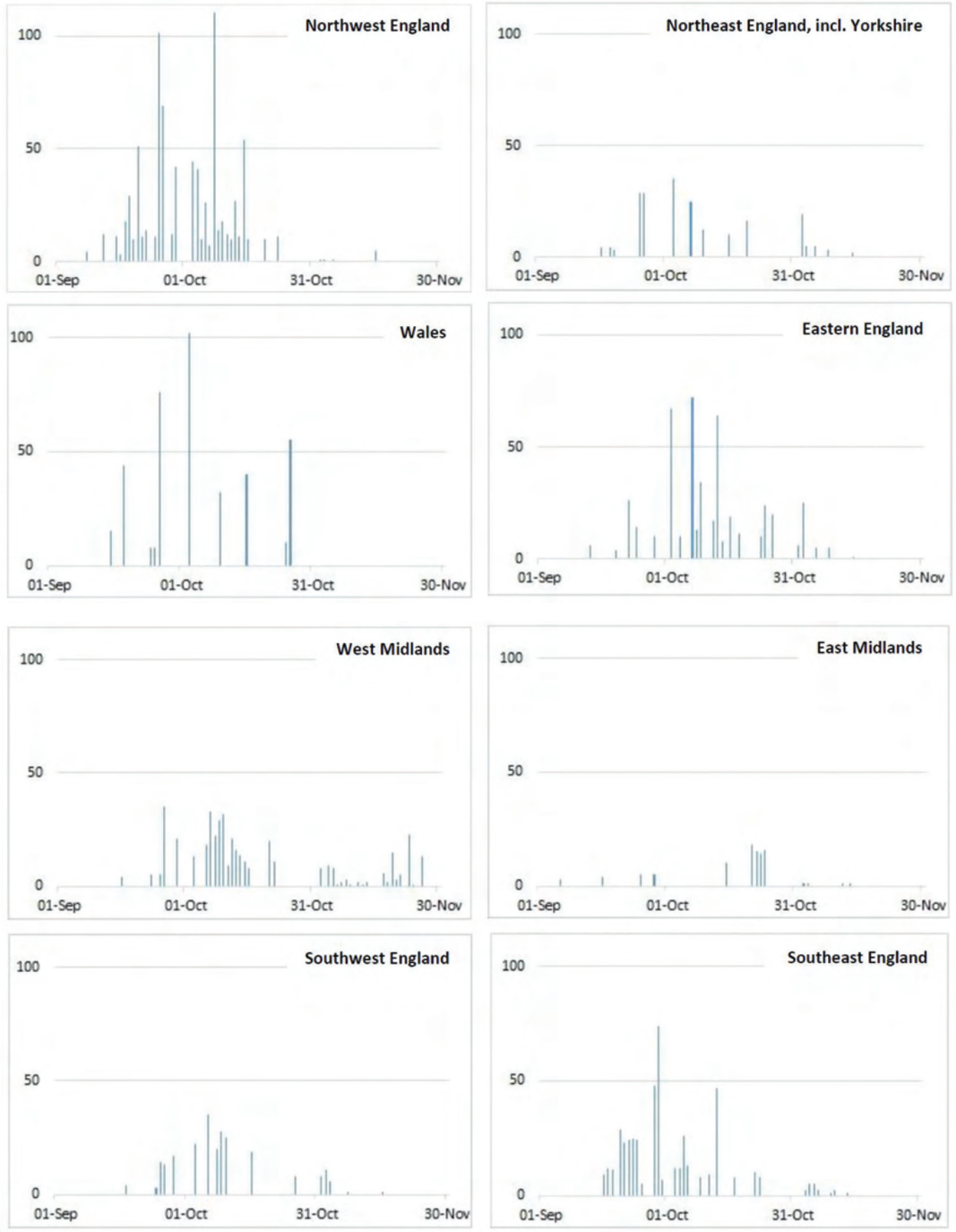


Figure. 4. Visible migration counts of Jay submitted to Trektellen.nl in autumn 2021, aggregated by date.

Jay records during the previous decade

Comparisons with BirdTrack lists submitted during the previous nine years show that the reporting rate in October 2021 (25.4% of lists) was the highest of any month in the time series. However, the chance of an encounter with a group of Jays was only marginally higher in 2021 than in previous autumns (fig. 5), and lower than in 2014, when 15 counts of 10-30 Jays were reported (Welsh Bird Report 2014).

The total number of Jay records submitted during autumn months over the period (fig. 6) has increased, but so has participation in BirdTrack, making it a less useful measure of trend. Figure 7 shows that almost twice (195% of the 2012-20 average) the number of Jays was seen per record in autumn 2021. The difference was greatest in October (252% of the 2012-20 average), but in November, the minimum number of Jays per record returned to normal. The highest counts submitted to BirdTrack in September and October 2021 were exceptional, and even the highest in November 2021 was larger than the same month during the previous decade (fig. 8).

Of the Jay records from Wales submitted to BirdTrack since 1958 (n=31,767), 15 of the 20 largest counts were in autumn 2021, ranging from 32 to 300 individuals. Those five not in 2021 were from Strumble Head (Pembrokeshire) in October 1983, Cnwch (Ceredigion) in August 2013, Margam (Gower) and Peterstone Gout (Gwent) in September/October 2014 and Skomer (Pembrokeshire) on the surprising date of 28 June 2013.

Jays in gardens

Records submitted to the BTO Garden Birdwatch have shown a consistent pattern in almost every year since 1995. In Wales, the proportion of gardens in which Jay is reported generally peaks in June and reaches its lowest point in September, before climbing to a second peak in November, sometimes later. The number of Jays recorded, taken as a weekly average, typically peaks in July, but otherwise shows a similar pattern to the reporting rate.

Counts by BTO Garden Birdwatch participants in Wales showed significantly higher numbers of Jays in autumn 2021 than in previous years ($p < 0.001$), measured both by the reporting rate (fig. 9) and the number of individuals per record (fig. 10). Reporting rates in autumn 2021 were more than twice the average of the previous decade: 177% of the 10-year average in September, 221% in October and 215% in November. Indeed, the Garden Birdwatch reporting rates in October 2021 (29.6% of gardens) and November 2021 (31.7%) were higher than in any other month since recording began in 1995. The number of birds involved was also above average: 0.22 birds/garden/week in September 2021 (cf. 0.12 in September 2011-20), 0.37 in October (cf. 0.16) and 0.42 in November (cf. 0.18). The November average weekly count in 2021 was higher than the previous maxima in July 2012 (0.39), in a time series back to January 2003.

Of the 27 years for which data is available, the only years in which the autumn/early winter maxima exceeded those for the summer of that year (shown as a black stripe in figures 9 and 10) were

Figure. 5. BirdTrack reporting rate during autumn months in Wales, 2012-21.

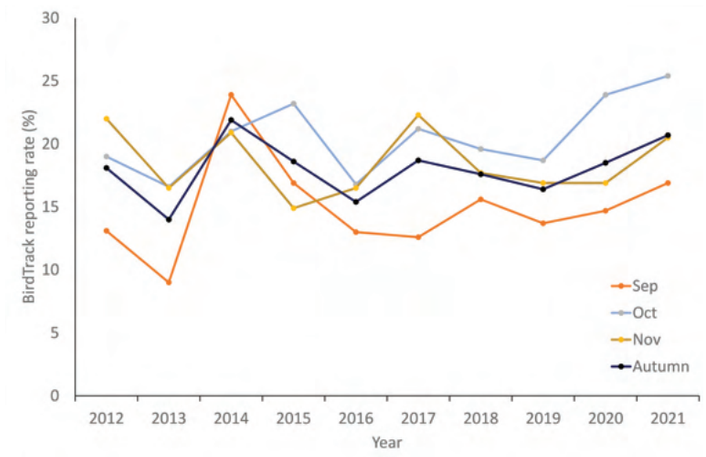


Figure. 6. Number of Jays reported to BirdTrack in Wales, 2012-21.

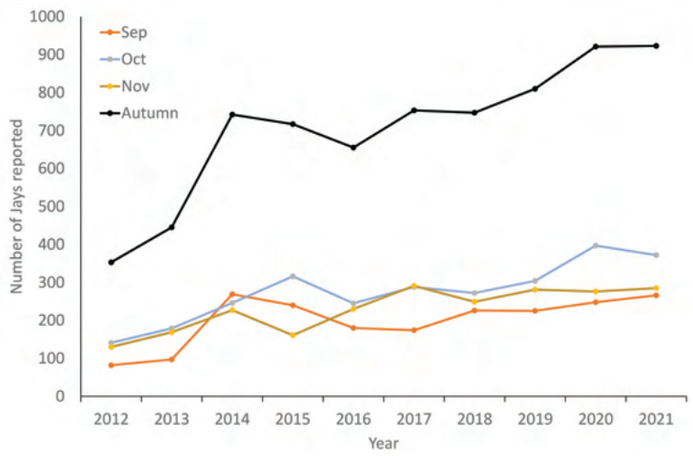


Figure. 7. Average number of Jays per record submitted to BirdTrack in Wales, 2012-21.

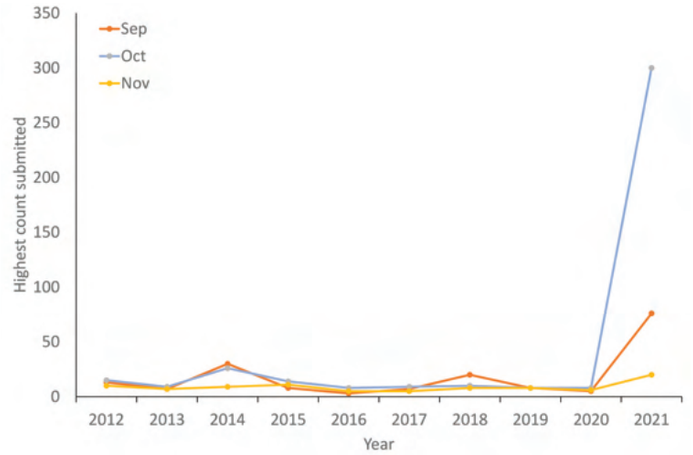


Figure. 8. Highest count submitted to BirdTrack in Wales in each autumn month, 2012-21.

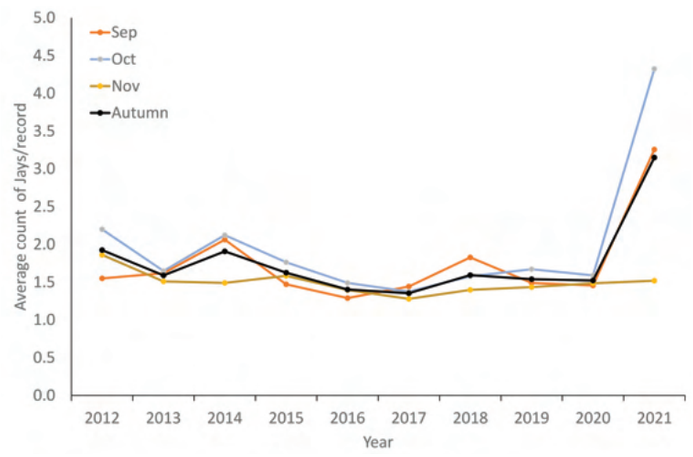


Figure. 9. Percentage of gardens in Wales from which Jay was recorded by BTO Garden Birdwatch participants.

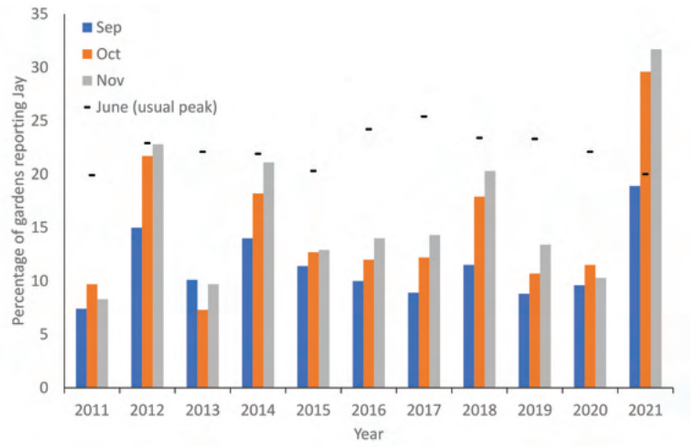


Figure. 10. Average number of Jays recorded per garden in Wales by BTO Garden Birdwatch participants.

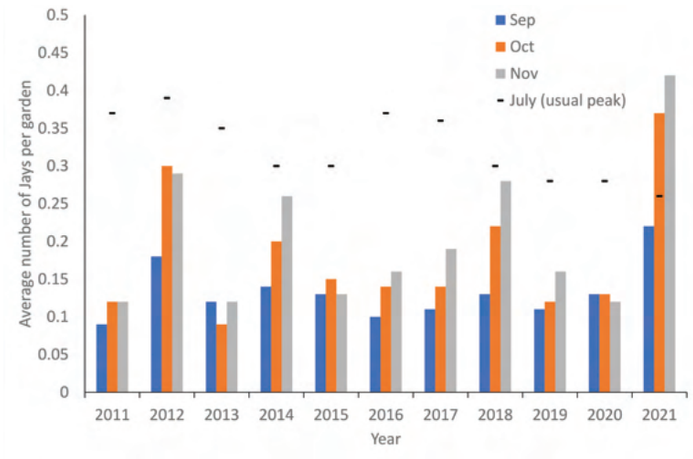


Figure. 11. Mean fruit scores for Pedunculate Oak (Quercus robur) and Sessile Oak (Quercus petraea) assessed by contributors to Nature's Calendar (Woodland Trust), 2001-21. The sample size was too small for Sessile Oak in Wales in 2020.>

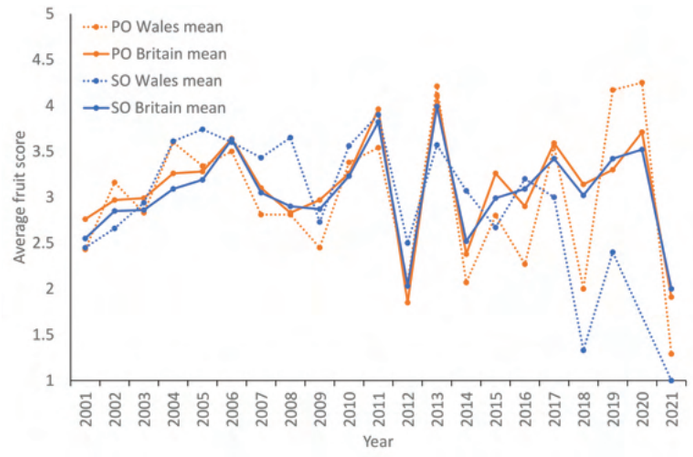
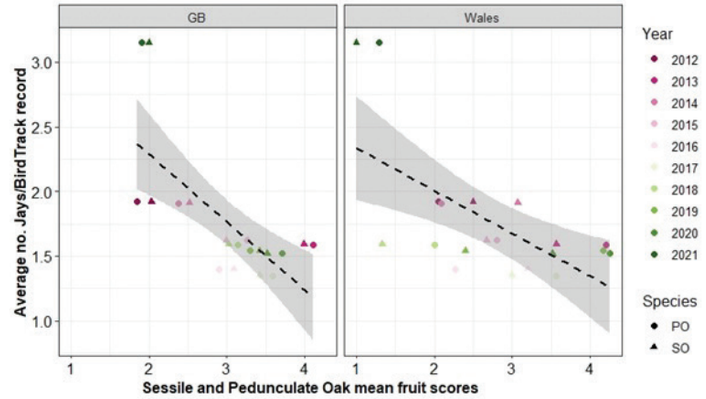


Figure.12. Relationship between autumn numbers of Jays in Britain and Wales (BirdTrack) and oak fruiting scores in Great Britain (Nature's Calendar - Woodland Trust), 2012-21. Points marked with circles are Pedunculate Oak (Quercus robur) and those with triangles are Sessile Oak (Quercus petraea).>



1996, 2005, 2009 and 2021. These may all have been years of immigration into Wales, albeit in numbers that were not detected as notable at the time.

Abundance of oak mast

The annual mean and mode fruit scores for Pedunculate Oak and Sessile Oak were calculated for Britain, and each constituent country/region. Both methods highlighted years of above-average fruiting scores (2006, 2011, 2013, 2017 and 2020) in each species, and a few that were below average (2012, 2014 and 2021). In most years, the mean fruiting score for both oak species in Wales was broadly similar to the rest of Britain (fig. 11), but there were years of lower synchronicity, such as in 2016 (Pedunculate Oak only), 2018 and 2019 (both species). The scores also show strong synchronicity in fruiting between the two species at a UK level, and broadly in Wales except in some of the later years, which may be a product of diminishing sample sizes (especially in 2020, when COVID-19 may have contributed to lower participation). The fruiting scores for both oak species across Britain were significantly lower in 2021 than the previous eight years (ANOVA, range of difference in fruiting score = -0.47 to -2.12, $p < 0.0001$) but not significantly different from those in 2012 ($p = 0.676$), whereas the scores for both species in Wales in 2021 were far lower than in any autumn of the 21-year dataset.

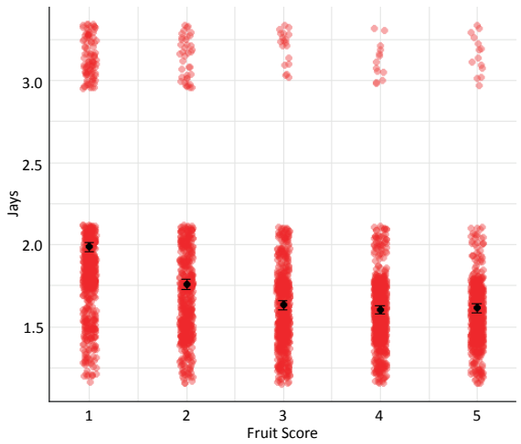


Figure.13. Relationship between the number of Jays in Wales (BirdTrack) and the oak fruiting score in Britain (Nature's Calendar - Woodland Trust), 2012-21. >

The relationship between the mean number of individual Jays per BirdTrack record in Wales and the mean fruiting score for each oak species is shown for Britain and Wales (fig. 12). There was no significant difference in the number of Jays between Britain and Wales when the difference in the fruiting scores has been accounted for (GLM, mean = 0.01 +/- 0.02, $p = 0.517$) but there was a significant negative relationship between the number of Jays and the fruiting score, i.e. the number of Jays was lower when the fruiting score was higher (fig. 13). An increase of fruit score by approximately 1 (0.92) would result in a decrease in the number of Jays by 10 ($p < 0.0001$). The reduced power of the smaller sample size for Wales may explain why there appears to be less synchronicity between Pedunculate and Sessile Oak within the same year than is evident for Britain as a whole. Nonetheless, the paucity of acorns available in Britain, and especially in Wales, in 2021 coincided with the greater abundance of Jays in Wales.

Discussion

Comparison of 2021 movements in Wales to 1983

The 2021 recorded Jay movement was far larger than that of 1983, and far more widespread. The largest counts were between 18 September and 16 October, with smaller groups seen, especially in East Glamorgan, until 25 November. East Glamorgan accounted for 32% of counts >=3 in Wales and the largest single site-day count, of 300 at Dunraven, on 6 October. Pembrokeshire (12%), Caernarfonshire (12%) and Gwent (10%) were the other three recording areas that witnessed significant numbers, but every coastal county recorded at least one flock or site-day count of 10 or more Jays.

There were more records from inland sites (>1km from the sea or a tidal estuary) in 2021 than in 1983, but the numbers were small compared to the coast. The most notable day counts (table 3) were 23 in the Ogwen Valley, Caernarfonshire (12.6km from the sea), 18 at Cwm Cadlan NNR, East Glamorgan (29.3km), 13 at Llyn Llech Owain, Carmarthenshire (16.5km) and 12 at Garwnant Forest Centre, East Glamorgan (35km). A visual assessment of the distribution of records (fig. 2) suggests that birds followed wooded valleys such as the Conwy and those in southeast Wales, although in northeast Wales, the records are associated with the Clwydian hills (max. elevation 554m, Moel Famau). The largest count from the land-locked counties of Mid Wales was a flock of seven at Llanidloes, Montgomeryshire, on 6 October.

The average count/BirdTrack record was higher than usual in September 2021 and highest in October, before it returned to the average for the last decade in November. However, both the reporting rate and average maximum weekly counts from the BTO Garden Birdwatch showed a consistent increase over successive autumn months, and was highest in November 2021. This supports the observations that birds moved towards the Welsh coast in flocks of various sizes, and then dispersed across the landscape, including to gardens.

Origin of Jays in Wales during autumn 2021

In 2021, counts made in eastern France, the Low Countries and western Germany between mid-September and mid-October were higher than usual (eurobirdportal.org), but there was no evidence of westward movement across the North Sea. For example, Falsterbo Bird Observatory in southern Sweden recorded no large movements of Jays in autumn 2021 and there were few notable counts of Jays from bird observatories and coastal watchpoints on the east coast of England in 2021. The monthly maxima at Sandwich Bay Bird Observatory (Kent) were five on 29 September and 25 on 13 October; at Dungeness Bird Observatory (Kent), no Jays were logged in September and the maxima in the following months were 10 on 8 October and three on 8 November; at Spurn Bird Observatory (East Yorkshire), the highest counts were six on 26 September and in October, 11 on 5th, seven on 6th, 10 on 10th and six on 11th; at Hunmanby Gap and Flamborough Head (North Yorkshire), the only multiple record was two Jays on 5 November. Visible migration of Jays reported to Trektellen during autumn 2021 is entirely absent from the Scottish and Northumberland coasts, and most of those recorded in Yorkshire were well inland. Counts were also low in the East and West Midlands compared to Wales, and only site in eastern England with multiple large counts was Hunstanton in northwest Norfolk (max. 72 on 7 October), suggestive of birds crossing The Wash south from Lincolnshire rather than arriving from overseas. There is no evidence of a continental origin for the Jay movements to Wales in autumn 2021.

Within Britain, counts submitted to Trektellen were higher in Wales than for any other part of the country (fig. 4). Unlike in autumn 1983, when the greatest numbers were in Cornwall, counts in southwest England in autumn 2021 were above average but unremarkable compared to the rest of southern Britain. In 1983, Jays funnelled down the isthmus towards Land's End, perhaps having originated in central and southern England. In 2021, some of those recorded in South Wales perhaps also set out from woodlands in central and southern England, but there were probably also birds from northern Britain, especially the northwest, that made their way to North Wales synchronously.

Dispersal of Jay flocks

During September-November, the average date of inland Jay records was a week later (17 October, day 290) than those on the coast (10 October, day 283). Although large and very large flocks (>=12 birds) continued to be recorded through the remainder of the autumn, there were no significant movements after the end of October. November records of three or more Jays were predominantly from southeast and northeast Wales, which may be indicative of birds moving out of Wales.

There is no evidence that birds crossed from Wales to Ireland and it is most likely that flocks dispersed rapidly across the countryside within Wales, with at least some into gardens. The reporting rate and the average number of birds per garden in November was the highest ever recorded in Welsh gardens by the BTO Garden Birdwatch. Anecdotal comments on social media also provide some evidence of Jays in gardens from which they had previously been rare or absent, through the following winter. Having failed to find a plentiful supply of acorns anywhere in mainland Britain in autumn 2021, Jays would have switched natural diet in woodland and then moved into gardens as those supplies ran out.

Dispersal of Jays into gardens was recorded across Britain by the BTO Garden Birdwatch in autumn 2021, but achieved record totals (of average maximum numbers, since 2003) in only three areas: Wales, West Midlands and Yorkshire & Humber. The reporting rates shown by country/region suggest dispersal into gardens in Wales, London, eastern and southeast England (table 4).

Although Jay numbers recorded in Welsh gardens fell away in December, counts continued to increase in some other areas, lending support to the idea that Jays remained itinerant through the winter and roamed widely back across the UK in search of food, having no insurance of a hoarded supply of acorns on which to fall back. As has been shown for Siskin and Coal Tit (McKenzie *et al.* 2007) in relation to Sitka Spruce (*Picea sitchensis*) cone production, it seems plausible that in years of poor oakmast production, Jays move into gardens and increase the proportion of supplementary food in their diet.

Cause of Jay movements

There is good evidence from elsewhere in northern Europe that the scale and extent of Jay movements is related to the volume of fruit (acorns) produced by oak species, combined with weather conditions (e.g. Selås 2017). However, whereas heavy snowfall in January/February and high rainfall in spring may be contributory factors there, long periods of lying snow in woodland are an increasingly unusual occurrence in Britain. January 2021 was colder than average and snow lay for several days across much of northern England and eastern Scotland in early February (metoffice.gov.uk). Jays may be able to survive these relatively short periods of bad weather by moving into gardens for supplementary food, although the BTO Garden Birdwatch reporting rate for these areas was only marginally higher during those two months in 2021. Spring 2021 was cold but rainfall was low (the driest April in the UK since 1980), so wet conditions are unlikely to have reduced Jay productivity dramatically. Thus, throughout the first half of 2021, Jays would have been able to live off the high oak mast levels from autumn 2020.

Pedunculate Oak in Britain has alternate boom and

Table 4. Reporting rate of Jay in gardens during autumn 2021 by BTO Garden Birdwatch participants.

Site	Recording area	Date	Count	Distance from coast (km)
Scotland	2.1	3.3	4.6	3.3
NE England	3.4	4.1	5.8	4.4
Ireland	4.7	4.2	7.6	5.5
E. Midlands	4.1	7.2	9.1	6.8
Yorkshire & Humber	7.9	11.6	14.5	11.3
SW England	9.4	14.4	14.9	12.9
NW England	10.4	15	18.4	14.6
W. Midlands	10.5	16	18.5	15.0
E. England	11.3	20.2	21	17.5
SE England	15.2	23.1	27.1	21.8
London	18.5	28	25	23.8
Wales	18.9	29.6	31.7	26.7

bust years for masting. At Silwood Park (Berkshire), for example, annual records during 1979-2021 show that 2020 was by far the highest year of acorn production in the 43 years of monitoring and that the 2021 crop was the lowest (twitter.com/crawley_mick/status/1455515879429582849). Sessile Oak is less predictable in its mast production, but the Nature's Calendar project results presented here suggest that the mean trend in mast is not dissimilar to Pedunculate Oak across Britain as a whole. Acorn production in Sessile Oak is correlated with spring temperature (Caignard *et al.* 2017), so the cold but dry conditions that enabled Jays to forage for hoarded acorns in spring 2021 would have contributed to reduced acorn production the following autumn. John and Roskell (1985) noted that temperatures in April and May 1983 were below average, and this is borne out by data in the Met Office archive, although unlike in 2021, that spring was also wetter than average (digital.nmla.metoffice.gov.uk).

Data bias

This review uses records gathered by a large number of individuals across Britain, relying on records of Jays (from BirdTrack, eBird, Trektellen and the BTO Garden Birdwatch) and oakmast (from Nature's Calendar) by dedicated volunteers. The data is unstructured and thus weaker than a tested survey methodology, since the sites selected for recording are not random and the proficiency and experience of the individuals is unknown. Caveats in the data are mentioned in the results, but the selection of reporting rate (%) as a metric for the BirdTrack and Garden Bird Survey data and the use of number of individual Jays per record provides a robust comparison between years during the period 2012-21. Furthermore, the alignment of results from multiple sources independent of each other increases confidence in the conclusion that the autumn 2021 movement of Jays was substantially higher than in the previous decade. It is not possible to account for recording effort in 1983, so the comparison with the movements in that year is speculative.

Conclusion

The movement of Jays into and within Wales in autumn 2021 is the largest recorded. As a mass influx it was short-lived, lasting just 2-3 weeks, and involved birds moving along both the north and south coasts of Wales, but especially the latter. The almost complete absence of acorns in Wales may indicate that the majority of Jays recorded in Wales originated from within Wales, moving from well-wooded inland areas in all directions until they reached the north, south and west coasts. However, there is empirical evidence that Jays also moved into Wales from northwest and central/southern England. After reaching and following the coast, birds aggregated at headlands, islands and on the edges of large bays. Having failed to find an abundance of acorns and unwilling to make a sea crossing, they dispersed quickly across the countryside, including into gardens where they could take advantage of supplementary food. The movements were triggered by a widespread failure of the acorn crop, synchronously across Britain, which may have been on an unprecedented scale because of particularly productive fruiting of acorns the previous autumn and clement weather that resulted in high overwinter survival of Jays and good conditions for breeding in 2021.

Acknowledgements

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Ethical statement

This material is the authors' own original work, which has not been previously published elsewhere. It is not currently being considered for publication elsewhere, reflects the authors' own analysis of citizen science data in a truthful and complete manner and properly credits the contributors. The results are appropriately placed in the context of prior and existing research. All sources used are properly disclosed and referenced. The author takes public responsibility for its content. No funding or payments were associated with this analysis and there is no conflict of interest to declare.

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Appendix 1

Table 1a. Counts of Jays in Wales between weeks 35 (30 Aug.-5 Sept.) and 47 (22-28 Nov.). Week 40 is 4-10 October.

Week	Gwent	E.Glamorgan	Gower	Carmarthen	Pembroke	Ceredigion	Brecon
35	0	3	0	0	0	8	0
36	0	12	0	0	0	0	0
37	0	119	7	0	0	0	6
38	108	169	30	17	46	66	5
39	146	29	21	10	38	0	0
40	30	751	7	15	371	18	0
41	15	63	80	0	18	4	6
42	4	47	0	0	7	0	4
43	6	99	0	3	4	0	0
44	0	49	18	0	0	0	0
45	0	33	3	3	0	0	3
46	9	18	3	13	4	0	0
47	10	19	0	0	5	0	0

Table 1b. Counts of Jays in Wales between weeks 35 (30 Aug.-5 Sept.) and 47 (22-28 Nov.). Week 40 is 4-10 October.

Week	Radnor	Montgomery	Meirionnydd	Caernarfon	Anglesey	Denbigh	Flint
35	0	3	0	0	0	4	6
36	0	0	0	0	0	0	0
37	0	4	0	8	0	0	0
38	0	0	4	20	0	7	0
39	0	0	0	51	0	0	4
40	0	7	8	194	110	21	8
41	0	0	20	48	8	29	14
42	0	0	0	0	5	3	0
43	3	0	3	40	11	3	6
44	0	0	0	4	0	8	0
45	0	0	0	10	4	3	4
46	0	0	0	0	0	3	0
47	0	0	0	0	0	3	0

Original Research

Observations of behaviours in males of a socially monogamous migrant passerine, Northern Wheatear (*Oenanthe oenanthe*), when attempting to mate outside of their social pair bond

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Key words: Extra-pair paternity; polygyny; Skokholm; extra-pair copulation

Abstract
Instances of males in a normally socially monogamous species seeking an additional partner in a polygynous relationship are well known, yet the courtship behaviours associated with these two scenarios are less well reported. Here we use observations arising out of an ongoing long-term study of Northern Wheatear to demonstrate the different behaviours adopted by males in these two situations, one being more frantic than the other. Furthermore, we report how the occurrence of extra-pair paternity (EPP, offspring that are not solely those of a female's socially bonded male) appears more widely exhibited in our study population than previously documented.

Introduction
The Northern Wheatear (*Oenanthe oenanthe*, henceforth 'Wheatear') is an early migrant passerine in Wales that breeds on open ground characterised by bare rocky areas and a short turf layer (Pritchard *et al.* 2021). Across Europe, the Wheatear has undergone a significant population decline of 71% since 1980 and is currently listed as amber conservation status in the UK (PECBMS 2020; Stanbury *et al.* 2021). While the decline has been less severe in Wales, the Welsh population has still declined by 48% since 1995 (Harris *et al.* 2020), due largely to habitat availability and management. Consequently, with such a decline in breeding pairs, it is unlikely to retain its current green conservation status in Wales (Johnstone and Bladwell 2016) at the next assessment, and may well be a candidate for red-listing (Pritchard *et al.* 2021). Wheatears breed both in lowland and upland habitats, where they nest in crevices or old animal burrows, and are reported on all the larger Welsh islands.

Wheatear males arrive on the breeding grounds before females (Conder 1989; Currie *et al.* 2000) with older birds arriving earlier than first year breeders (Conder 1989; Low *et al.* 2019). Wheatears are essentially monogamous, with pairs forming for the duration of each separate breeding season (Cramp 1988; Conder 1989; Clement and Rose 2015), and only females incubate. Males help with provisioning the young, although the extent of this parental contribution varies (Conder 1989). When the length of the breeding season and food availability allow, Wheatears can have two broods. For example, 47% and 58% of pairs had second broods on Skokholm from 1948 to 1951 (Conder 1989) and 2017 to 2021 (Beggs, I., *pers. obs.* 2021), respectively. In most cases, the pair bond extends to the second brood, with uncommon instances of birds changing partners between broods (Brooke 1979; Conder 1989; Hussell *et al.* 2014; Beggs 2019).

Polygyny in socially monogamous passerines is well reported (Moller 1986; Canal *et al.* 2020). An already paired male mates with both his socially bonded female and an unattached female usually, but not always, in an adjoining territory. There is a 'trade off' for the second female in potentially having to rear the young with the possible absence of parental care from the polygynous male (Canal *et al.* 2020). Instances of polygyny in Skokholm's wheatear population were first recorded in 1951

(Conder 1989). He described polygynous events in first broods involving paired and mated males that also mated with an unattached female and second brood polygyny, observing that it seemed to arise where an adjoining pair's male disappeared after the first brood.

Studies of the genotype to determine a bird's parentage have been carried out for over thirty years and the occurrence of offspring that are not solely those of a female's socially bonded male (extra-pair paternity - EPP) have been reported extensively. EPP occurs when a male (in a normally socially monogamous species) mates with a female outside already established pair bonds (Extra-Pair Copulation) and subsequently fathers young. That is, the eggs produced by the female contain offspring both from her socially bonded male and from the other male. It is generally accepted that EPP is a frequent and evolutionarily important aspect of the mating behaviour of birds (Valcu *et al.* 2021), and is widespread across avian populations with a recent review identifying over 500 separate studies relating to over 300 species (Brouwer *et al.* 2017). It is important to note that extra-pair copulation (EPC) attempts need to be allowed by the female for a successful extra-pair mating to occur, and that there are generally more attempts at EPC than result in offspring (Currie *et al.* 1998). Attempts at EPC have previously been reported in Wheatear (Carlson *et al.* 1985; Currie *et al.* 1998; Kudernatsch *et al.* 2010), and well-reported across socially monogamous passerines (Møller 1986; Canal *et al.* 2020). Kudernatsch *et al.* (2010) identified through DNA analysis that 26% of Wheatear offspring in 46% of broods were fathered by a male(s) different to the pair bonded male on territory. Similarly, on Bardsey Island in north Wales 11% of offspring in 29% of broods contained DNA from a male which was not the social partner, while only one out of seven attempted extra-pair copulations resulted in actual copulation (Currie *et al.* 1998). Condor (1989) stated that he had not seen any definite occurrence of EPC behaviour.

Here we report observations of extra-pair behaviours made during an ongoing study (commenced in 2017) of Skokholm Island's Wheatears. We report attempts by socially bonded males to mate with unattached females and form a polygynous relationship and secondly, we describe instances of EPC attempts by an already socially bonded mae with a female from another pair. We detail the different courtship behaviours exhibited by males in these two scenarios.

Study Site and Method

Much of the historic research on wheatears in the UK has occurred on Skokholm Island, Pembrokeshire (Brooke 1979,1981; Conder 1989). Skokholm has had a fluctuating Wheatear population of 7 to 38 breeding pairs (mean ± SD = 18.0 ± 8.07) since recording began in 1928 (Brown and Eagle 2021). Covering 106 ha of mainly maritime grassland, Skokholm Island (51°41.8663'N 5°16.6195'W) lies approximately four kilometres off the south-west coast of Pembrokeshire in St George's Channel. Along with neighbouring Skomer Island and the surrounding seas, it is designated as a Special Protection Area for its internationally important seabird assemblage as well as key populations of European Storm-petrel (*Hydrobates pelagicus*), Manx Shearwater (*Puffinus puffinus*), Atlantic Puffin (*Fratercula arctica*), Lesser Black-backed Gull (*Larus fuscus*), and Red-billed Chough (*Pyrrhocorax pyrrhocorax*) (JNCC 2019). Skokholm is owned by the Wildlife Trust of South and West Wales (WTSWW) who re-established the island's Bird Observatory in 2014.

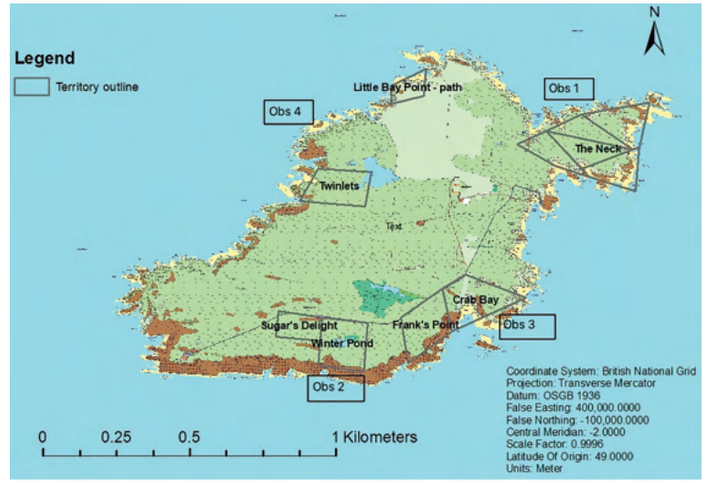
Since 2017, the island's wheatears have been individually colour-ringed to facilitate pair identification and territory mapping through the breeding season. During the field seasons of 2017 to 2021 there were between 18 and 29 pairs, annually (mean ± SD = 23.6 ± 3.50). All the observations detailed here relate to first brood mating activity and due to the nature of the study, it was not possible to closely observe pairs during the similar period in their second brood.

Observations of Courtship Behaviours

Polygynous relationships

Observation 1, 2018: Male A14 was in a mated pair with female A47 in the area known as The Neck (fig. 1). Their territory comprised the central part of this small peninsular. Both birds had held territories in the same general area in 2017 although with different partners. On 3 May 2018, male A14 was closely following female A56 who had been partnered with another male at the western end of The Neck; an obvious wall formed a territorial boundary. The original male had seemingly disappeared. Male A14 was singing softly and occasionally performing a display flight. Meanwhile female A47 was ~100 m away alarm calling around her and A14's established territory. Both females raised broods and no other males

Figure 1. Selected Wheatear territories on Skokholm Island between 2018-2021 showing locations of observations.



were seen associating with either female. Male A14 later paired with female A56 for a second brood. Female A47 was not observed that year after her first brood fledged.

Observation 2, 2019: Male A71 was paired with female B44 in the Winter Pond area (fig. 1). The boundary of their territory was an old wall to the east. Fifty metres further east another female, A50, had established a territory without any male. She was not seen to leave the territory at any point during the season. On 23 April 2019, male A71 was closely following female A50 in her territory and singing softly. When his female B44 appeared on the boundary wall he retreated to re-join his mate. Female A50 followed and he forcibly drove her away. Within 30 minutes female B44 had moved to the west of the territory and male A71 had returned to female A50's territory and was once again singing softly and following closely. Both females subsequently raised broods. No other male was observed interacting with female A50.

Extra-pair copulation (EPC) attempts

Observation 3, 2019: Male A61 was in a pair with female B41 in the Frank's Point area (fig. 1). On 1 May 2019 he appeared in Crab Bay and was displaying vigorously to the resident and paired female. Rather than the soft singing of previous observations, this was a frenzied and energetic display given in ~10 second bursts, closely resembling that described as a 'dancing display' (Conder 1989), which has also been observed (as 'rapid events') on Bardsey Island, northwest Wales (Currie *et al.* 1998), and used mainly between mated pairs in a sexual context (Cramp 1988; Conder 1989). The resident female flew away to the other side of the territory and was not pursued by male A61. Twenty minutes later male A61 was on his own territory closely associating with his mate, female B41. Although the two territories are shown as adjoining on the map there is no line of sight from the centre of one territory to the other, and birds are not involved in territorial conflict as there is a natural 'no man's' land in between.

Observation 4, 2021: Male C40 was paired with female A27 in the Twinlets area (fig. 1). On 14 April 2021 he was seen to be displaying vigorously in the Little Bay Point area to resident female B20 who was paired with another male in that territory. The display was frantic and rapid, and a full dancing display (Conder 1989). The resident male B52 appeared and, following both males displaying aggressively with what has been described as the 'flashing display' (Conder 1989), male C40 was driven away. These two territories are not close, being ~700m apart with two other territories in between. Three days later male C40 was seen back on his original territory with female A27.

There were two other similar observations (5 and 6) on 17 April & 18 April 2021 although neither was observed in as much detail as the previous four observations. They were two separate events with different birds, one in the Twinlets area and one in the Sugar's Delight area (males A31 & B49 respectively) (fig. 1). Both involved the rapid and vigorous displays highlighted in observations 3 and 4 above. In both cases the male returned to his socially bonded female shortly afterwards.

Discussion

The observations detailed in this article support the idea that a different behaviour is exhibited by males in encounters where a polygynous relationship is being sought as opposed to an EPC attempt. The encounters do not need to be frantic or quick. They are not opportunistic in the sense of having a short time window. Behaviours such as using a warbling sub-song and closely following the females were both observed in the two observations leading to polygynous relationships documented here (observations 1 and 2). These actions were not seen when the courting male was intruding on a mated pair's territory as described in observations 3-6. Cases of a male mating with an unattached female in an adjoining territory are uncommon in that they require an unpaired female to be available. They rely on unattached females being present due to the lack of a male which leads to them establishing their own territories or by the sudden disappearance (e.g., death, post breeding dispersal) of their partner. Hence, they are more likely to occur where (i) it is possible to have second broods and (ii) some males have disappeared.

The observations suggest that attempts at EPC are far more frequent on Skokholm than have been previously suggested during the earlier studies by Conder (1989). . Their frequency is more consistent with those documented on Bardsey (Currie *et al.* 1998; Currie *et al.* 1999). The four observations of attempted EPC all involved a rapid, frantic display by intruding males approaching the female and launching into the Dancing Display (Conder 1989). This is not altogether surprising as the courted female would be mate guarded by her social partnered male (Carlson *et al.* 1985). Consequently, his absence would only ever be temporary and, as in observation 4, a returning male would vigorously defend the territory and drive off any intruder.

There have been no genetic studies to establish the extent of EPP in Wheatears on Skokholm. To understand the extent of EPP in this study population it would be necessary to conduct a genotype study which would enable a better understanding of the frequency of EPP in a relatively dense population where most of the territories abut. Male polygyny and EPP are two facets of the Wheatear's breeding strategy and a better understanding of these two behaviours will enhance our understanding of the species' overall strategy and therefore aid conservation efforts. This applies to both populations that currently appear stable and those which may be declining due to threats such as changes in land usage or global threats such as climate change.

Acknowledgements

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Ethical statement

The observations contained in this article are possible becase Wheatears are all colour ringed. Trapping and ringing of birds in the UK are licensed by the British Trust for Ornithology (BTO). All ringing of Wheatears caught in this project was carried out by a BTO licensed bird ringer holding the necessary lienses and endorsements in accordance with the BTO Ringers' Manual (Redfern and Clarke 2001) and other guidance. The project is also registered with the BTO as a Colour Ringing Project.

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Image: David Gilbert

Review

Cardiff's Roof-nesting Gulls

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Key words: Urban gulls, colour-ringing

Abstract
Cardiff has supported a population of roof-nesting gulls at least since 1962. Six surveys have documented demographic changes in the colony and the population development of Herring Gulls (*Larus argentatus argenteus*), Lesser Black-backed Gulls (*Larus fuscus graellsii*) and Great Black-backed Gulls (*Larus marinus*) in Cardiff from 2003 onwards. As of 2017, there were 2,301 pairs of Lesser Black-backed Gull, 838 Herring Gull pairs, and eight Great Black-backed Gull pairs breeding in the city. A total of 687 Herring and Lesser Black-backed Gulls have been colour-ringed over 14 seasons, with 319 individuals (46.6% recovery rate) amassing 2,172 post-fledging records. Urban-hatched young from Cardiff do not recruit into rural colonies. It is therefore important that urban populations are properly understood in their individual contexts so that any management considerations are appropriately informed.

Introduction
Cardiff (51.29N 03.11W), was estimated to support a human population of 364,200 in 2018 equating to 11.7% of the population of Wales (ONS 2020) in an area of 149.4km2 (ONS 2021). Cardiff's gulls, however, breed on roofs only in the urban and industrial areas of the city. The only record of ground-nesting in the city was attempted by several pairs in 2006 on a cleared site after the demolition of warehousing in Llanishen (Rock 2006a); they are thought to have failed. In 2017 Cardiff's roof-nesting gull population stood at 3,147 pairs (Rock 2017).

The colour-ringing of urban gull nestlings (the Bristol Scheme) began in Bristol in 1980, extended to Bath in 2001, to Cardiff in 2003 and to Gloucester in 2007 (i.e. four of the largest colonies in the Severn Estuary Region). Various other locations have been visited as opportunities presented themselves (e.g. Barry, Bridgend and Margam on the Welsh side). The purpose of extending the study was to begin to understand recruitment between colonies. As of 2021, 687 Herring and Lesser Black-backed Gulls have been colour-ringed in Cardiff since 2003.

The history of gulls breeding in Cardiff
Cardiff has supported urban-nesting gulls since at least 1962 (Cramp 1971), the city being listed as a new, mixed colony with 15-20 pairs. However, compared with Gloucester and Bristol which were found to have tiny numbers on their discovery, namely three pairs in Gloucester in 1967 (Owen 1967) and one pair in Bristol in 1972 (P. Chadwick, *pers. comm.*), it is entirely feasible that Cardiff was first colonised a year or more earlier.

By 1969 the Cardiff population had risen to 68/69 pairs (Monaghan and Coulson 1977) with 45 pairs of Herring Gulls and 23/24 pairs of Lesser Black-backed Gulls. In 1975 this number had risen to 581 pairs (i.e. 425 pairs of Herring Gulls and 156 pairs of Lesser Black-backed Gulls) and, possibly, as a result of botulism (*Clostridium botulinum*), fell to 360 pairs (i.e. 192 pairs of Herring Gulls and 168 pairs of Lesser Black-backed Gulls) in 1980 (Mudge and Ferns 1980). No details could be found for population figures between then and 1994 when 28 pairs were recorded (Raven and Coulson 1997). Beyond that, Seabird 2000 (Mitchell *et al.*. 2004) listed three roof-nesting colonies in South Glamorgan as supporting 72 pairs, of which 56 pairs are listed for Cardiff in 2002 (JNCC 1998-2002). In 2003 the Cardiff population was assessed at 2,727 pairs (Rock 2003) with the latest survey in 2017 revealing a population of 3,147 pairs (Rock 2017).

The Cardiff colony
At 3,147 pairs, Cardiff could be the largest urban gull colony in UK. Aberdeen, though, has always been a very large colony. Raven & Coulson (1997) listed 2,000+ pairs and Mitchell *et al.* (2004) listing 3,793 AON (Apparently Occupied Nests (i.e. pairs)) of Herring, Common, Lesser and Great Black-backed Gulls in descending order. However, survey work undertaken in Aberdeen in 2021 suggests that the population has declined over 20 years, with initial raw counts suggesting at least 2,600 pairs, subject to checking and final adjustment (A. Perkins and I. Francis, *unpubl. data*). Even if Cardiff is the largest colony in UK, it is certainly not the largest urban gull colony in the World. Minsk (Belarus) could well be: it supports circa 10,000 pairs with almost 5,000 pairs (mainly Caspian Gulls (Larus cachinnans)) breeding in a small trading estate with one roof measuring 12 hectares! (I. Samusenko *pers. comm.*).

Six surveys have been conducted in Cardiff (Rock 2003, 2004a, 2005a, 2006a, 2011 and 2017) which have documented population and demographic changes in the colony. While there has been variation in the size of the Cardiff colony in the years after Seabird 2000, hereafter S2000 (Mitchell *et al.* 2004), the population has never been below 2,700 pairs and, mostly, above 3,000 pairs. A number of factors account for the variations in colony size and in demographic shifts within the colony. As with all urban gull colonies studied, redevelopment is the principal driver of displacement of breeding pairs (*pers. obs.*). The demolition of preferred breeding roofs (often elderly, dilapidated buildings and often with asbestos roofing) forces breeding pairs to move. Similarly, roof-netting can prevent gulls nesting on particular roofs provided it is correctly installed.

Herring and Lesser Black-backed Gulls are long-lived and, apart from survival, breeding is the most important aspect of the lives of the large gulls (Rock 2005b) and, probably, of all bird species. Longevity records are very close to 35 years for both species (Euring 2017). Thus, displacement always results in relocation either within the colony or to another colony or even to as yet uncolonised urban areas (Rock 2005b). Major redevelopment coupled with widespread netting of roofs as well as smaller redevelopment projects and on-going roof-maintenance in breeding seasons during the 14 years between the first and latest surveys have, without any doubt, affected breeding numbers and the density of breeding in certain areas.

The Cardiff population saw rather dramatic rises in 2004 and 2005 of 13.8% and 12% respectively, very much in line with other populations in the Severn Estuary Region at that time (e.g. Rock 2004b, 2004c, 2004d, 2006b), the mean rate of increase being 17.6%. However, a very dramatic drop in

Figure 1. Cardiff gull population 2003-2017

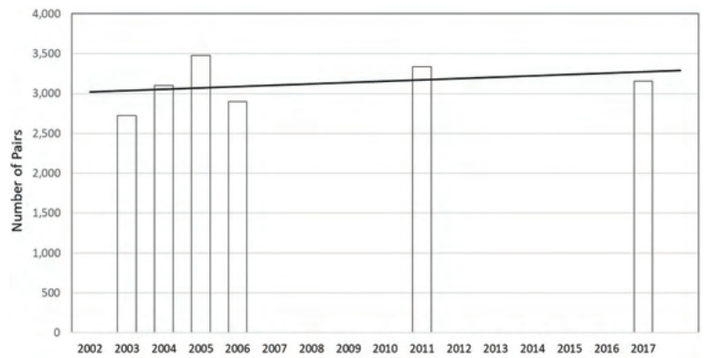


Table 1. Total numbers and population percentages of roof-nesting gulls in Cardiff, 2003-2017. LBBGU = Lesser Black-backed Gull, HERGU = Herring Gull, GBBGU = Great Black-backed Gull.

Year	LBBGU	HERGU	GBBGU	Total	LBBGU	HERGU	GBBGU
2003	2,134	593	-	2,727	78.25%	21.75%	-
2004	2,508	595	-	3,103	80.83%	19.17%	-
2005	2,842	632	1	3,475	81.78%	18.19%	0.03%
2006	2,431	468	-	2,899	83.86%	16.14%	-
2011	2,668	640	3	3,311	80.58%	19.33%	0.09%
2017	2,301	838	8	3,147	73.12%	26.63%	0.25%

numbers of 16.6% was noted in 2006 principally as a result of demolitions in Llanishen and the Steelworks. This was the first decline in numbers of any colony in the Severn Estuary Region post-S2000 (*pers. obs.*).

In the five years succeeding 2006 the population recovered somewhat only to fall again by 5% in the six years to 2017 (i.e. by 0.83% per year) as a consequence of further demolitions and on-going roof maintenance during the breeding season. The proliferation of roof-netting in various locations throughout the city, but particularly in the city centre, displaced an indeterminate number of pairs. Interestingly, Cardiff Docks saw an increase of 125 pairs (59.2%) and a new colonisation took place in a residential area close to Roath Park Lake. Further, the Treforest industrial estate saw an 11-fold increase from 6 pairs in 2011 to 75 pairs in 2017. It is tempting to suggest that some or many of these new recruits will have been displaced breeders from within the Cardiff boundary, but without evidence in the form of colour-ringed birds, this can only be speculative.

Three gull species breed on Cardiff rooftops, namely Herring, Lesser and Great Black-backed Gulls. Most of Cardiff's Great Black-backed Gulls breed in the docks. As the top predator in seabird colonies, some have a penchant for eating the eggs and chicks of the other species (*pers. obs.*). Since 2003 the Cardiff population has been dominated by Lesser Black-backed Gulls (Mean Ratio=4:1, Range=2.7:1 to 5.2:1). This was not always the case. Mudge and Ferns (1980) relate that in 1975 the population was very much dominated by Herring Gulls (2.7:1), but that by 1980 the ratio (1.1:1) was close to parity. Perhaps, this is when the Lesser Black-backed Gull began to dominate. Serious declines (>50%) both in breeding and non-breeding populations have resulted in the Herring Gull being Red-Listed as a species of conservation concern in 2015 (Eaton *et al.* 2015). Continuing declines have underpinned its Red-List status (Stanbury *et al.* 2021). However, much of the data used to determine the scale of declines was derived from rural colony censuses, rather than at urban colonies (JNCC Seabird Censuses: https://jncc.gov.uk/our-work/seabird-censuses/). In several urban gull colonies in the Severn Estuary Region Herring Gull breeding numbers have shown moderate increases (e.g. Bath 1995-2015, Rock 2015).

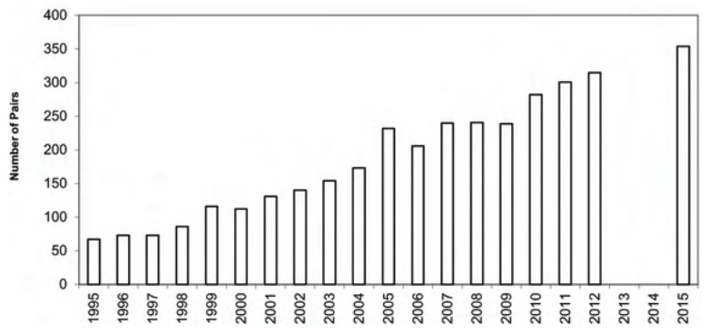
The 2017 Cardiff survey revealed the highest proportion of Herring Gulls since 2003 (i.e. 26.6% of the population). Further surveys will reveal whether or not this represents a resurgence of this species.

Urban colonies surrounding Cardiff

Seabird 2000 (Mitchell *et al.* 2004) listed just 239 colonies in UK & Ireland. The register I have been assembling (which is by no means complete) stands at 563 colonies so far with a minimum of 117 colonies in the Severn Estuary Region (unpubl. data). Cardiff, whilst easily the largest colony in Wales, is nowadays surrounded by at least 59 colonies of varying sizes ranging from a handful of pairs to several hundred (e.g. Rock 2004e) within circa 70km.

Of the 59 colonies surrounding Cardiff (fig. 2), 22 were listed by The Seabird Colony Data (JNCC 1998-2002) – i.e. nine of the 26 Welsh colonies and 13 of the 33 English colonies. Some of the Welsh colonies were possibly known at the time of S2000, but certainly known not long after, viz. Bridgend (Rock 2003b). Some colonies, e.g. Trethomas, Pontllanfraith Rogerstone have become established relatively recently with only a few pairs (*pers. obs.*), but with time and without disturbance will very likely have increased in size

Figure 2. Increases in numbers of breeding pairs in Bath between 1995-2015.



by now. Each of these urban colonies will have been importing and exporting recruits ever since they were established. The principle is that males tend to return to their natal colonies once they are old enough to breed (at between three and five years of age), whereas females tend to emigrate (Rock 2005b). Displacement (inevitably) interferes with this tendency, forcing birds of both sexes to move. Thus, because of its size, it can be expected that Cardiff is a major importer and exporter (see below).

Colour-ringing in Cardiff

In 1980 the colour-ringing of the large gulls changed. The use of large, individually-coded, plastic rings gave rise to very high recovery rates and, therefore, created the opportunity to investigate the lives of the large gulls in considerable detail. Not to do so, it could be argued, could limit the scope of any study on these species (Rock 1999). Prior to 1980, combination colour-ringing using stacks of unmarked, coloured bands was common, but the loss of one band from a stack could render the identification of individual birds impossible. Colour-rings are, typically, 35mm tall with codes engraved vertically three times around the ring and are placed on one tarsus with metal rings on the other. This system was quickly employed by several other schemes in UK and abroad because it offered considerable certainty, generated a great deal of interest amongst observers and is now universal (viz. http://www.cr-birding.org/).

The Bristol Scheme was established in Bristol in 1980, focusing exclusively on the ringing of nestlings (i.e. birds of precisely known age and origin) on rooftops. It was the first study to investigate urban gulls in Europe. In 2001 it was expanded to include other urban colonies in the Severn Estuary Region in order better to understand between-col-

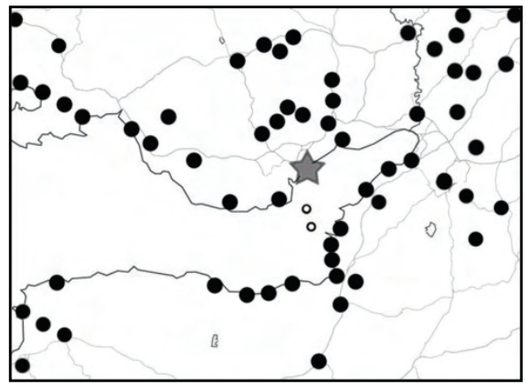


Figure 3. Approximate locations of 59 urban gull colonies (●) surrounding Cardiff (★). ○ = Flat Holm and Steep Holm islands.

Table 2. Cardiff colour-ringing totals 2003-2021 with annual species percentages. HERGU = Herring Gull; LBBGU = Lesser Black-backed Gull.

Cohort	HERGU	LBBGU	Total	Count	HG%	LB%
2003	7	22	29	1	24.1%	75.9%
2004	3	25	28	1	10.7%	89.3%
2006	6	11	17	1	35.3%	64.7%
2011	10	38	48	1	20.8%	79.2%
2012	9	37	46	1	19.6%	80.4%
2013	12	50	62	1	19.4%	80.6%
2014	12	32	44	1	27.3%	72.7%
2015	4	22	26	1	15.4%	84.6%
2016	6	24	30	1	20.0%	80.0%
2017	7	65	72	1	9.7%	90.3%
2018	11	46	57	1	19.3%	80.7%
2019	14	55	69	1	20.3%	79.7%
2020	7	77	84	1	8.3%	91.7%
2021	14	61	75	1	18.7%	81.3%
Total/mean	**122**	**565**	**687**	**14**	**$\bar{x}$=17.8%**	**$\bar{x}$=82.2%**

Table 3. Ringing totals, recoveries and recovery percentages for Herring and Lesser Black-backed Gulls in Cardiff 2003-2021. HG = Herring Gull; LB = Lesser Black-backed Gull; Recovs = recoveries; Recov% = recovery rate (percentage). The recovery rate is the number of individuals recorded after fledging divided by the number ringed.

Year	HG Ringed	HG Recovs	HG Recov%	LB Ringed	LB Recovs	LB Recovs%	All Recovs	Both
2003	7	5	71.4%	22	13	59.1%	18	62.1%
2004	3	3	100.0%	25	19	76.0%	22	78.6%
2006	6	2	33.3%	11	7	63.6%	9	52.9%
2011	10	4	40.0%	38	29	76.3%	33	68.8%
2012	9	3	33.3%	37	21	56.8%	24	52.2%
2013	12	4	33.3%	50	21	42.0%	25	40.3%
2014	12	6	50.0%	32	15	46.9%	21	47.7%
2015	4	3	75.0%	22	9	40.9%	12	46.2%
2016	6	3	50.0%	24	11	45.8%	14	46.7%
2017	7	3	42.9%	65	30	46.2%	33	45.8%
2018	11	3	27.3%	46	22	47.8%	25	43.9%
2019	14	6	42.9%	55	27	49.1%	33	47.8%
2020	7	4	57.1%	77	28	36.4%	32	38.1%
2021	14	2	14.3%	61	17	27.9%	19	25.3%
Total/mean	**122**	**51**	**x̄=41.8%**	**565**	**269**	**x̄=47.6%**	**320**	**x̄=46.6%**

ony recruitment. The four principal study sites are Bristol, Bath, Gloucester and Cardiff, but ringing has taken place in a further 11 locations as opportunities have arisen. Colour-ringing on rooftops in various parts of Cardiff started in 2003 and, so far, has achieved 14 seasons. The season is short (mid-June to mid-July) and, for the Bristol Scheme, intense, because of the large numbers of buildings to be visited in several locations, each requiring permission and RAMS (i.e. Risk Assessment and Method Statement), plus the restriction of having to operate only during business working hours. Usually, two or three days per year are given over to ringing in Cardiff.

In 14 seasons 687 birds have been ringed of which 319 have produced 2,172 post-fledging records (mean = 6.8 records per individual) and a recovery rate, up to press, of 46.6%. It is expected that this rate will improve somewhat before the end of July 2022 as individuals from the most recent cohorts are discovered, having so far remained under the radar, probably as a consequence of observers having to abide by SARS-CoV-2 restrictions for the last two years. The mean Bristol Scheme recovery rate over 40 years for both species is 60.4% which, in comparison to Cardiff's 46.6%, is, quite obviously, considerably higher. There are several reasons for this discrepancy. First, Cardiff is a very large city and whilst there are hotspots where gulls gather (e.g. Roath Park Lake, Mermaid Quay, etc.) and where colour-rings are often easily found and read, many gulls are widely dispersed and many areas have few or no suitable vantage points, except during surveys with the aid of cherry pickers. Further, as landfills closed (viz. Lamby Way in 2017) where numbers of gulls present could top 2,000 (*pers. obs.*) and as roof-netting proliferated, the opportunities for observing colour-ringed gulls in Cardiff and surrounds have dwindled (e.g. Langley *et al.* 2021). Colour-ring reading requires a certain kind of idiosyncrasy on the part of the observer as well as sufficient time. The vast majority of birders, for instance, do not visit industrial estates in the summer out of choice (where most gulls breed) to do their birding – apart from me! It is conceivable that the quality of the plastic used for making rings has declined somewhat. The reduction in recovery rates since 2012 appears to attest to this. Similar recovery rate reductions have been noted in the Bristol Scheme as a whole over the same period.

Lesser Black-backed Gulls

Traditionally, Lesser Black-backed Gulls were exclusively migratory, wintering mainly in Iberia and North Africa and even in the early 1950's very few were recorded in UK in winter (Barnes 1952). By 2013 an estimated 125,000 Lesser Black-backed Gulls were wintering in UK and Northern Ireland (Burton *et al.* 2013). Nine years on, it is suspected that rather more stay in UK instead of migrating to southern latitudes. Of 269 Cardiff individuals recovered (i.e. seen after fledging), 35 (13%) have been recorded in UK in winter (November to February). The Bristol Scheme rate stands at 28%. Of those 269, 13 (4.8%) first winter birds have been seen in UK in winter (November to February) and six (2.2%) have been seen between December and January (the depths of winter). The Bristol Scheme percentages are 2.6% and 1.1% respectively. The higher Cardiff percentages are due, almost exclusively, to committed ring-readers visiting gull hotspots in Cardiff during the winter and submitting their records which are gratefully accepted. With some variation between cohorts, approximately four Lesser Black-backed Gulls are ringed for every Herring Gull in Cardiff.

The overwhelming majority of Cardiff's (and Bristol Scheme) first winter Lesser Black-backed Gulls leave UK by October, but some leave their departures until after the beginning of November. Only those which have overwintered have been seen in UK in their first February (n=3). One bird stands out: ringed in 2017, Green4 G+X (a female) has only ever been seen in Cardiff. With 158 records, 75 of which are November to February, it can be confidently stated that she has never migrated because observation dates are so close together. This is a rare occurrence.

Cardiff's Lesser Black-backed Gulls follow the standard migration pattern for the species (Rock 2002), wintering, for the most part in Portugal and Spain. From recovery location data it would appear that the migration strategy of Cardiff's Lesser Black-backed Gulls is to make the short crossing of the English Channel and then move along the coasts "with occasional forays inland"; the traditional view (Baker 1980). One recovery location in the middle of the Bay of Biscay (one bird photographed from a marine research vessel) hints at a different possibility.

It is now clear that many Lesser Black-backed Gulls cross the Bay of Biscay or even miss it out altogether on their way to Spain and Portugal (Rock in prep). Furthermore, the 'occasional forays' inland may have been true back in 1980: Cantos *et al.* (1990) describe a new species (Larus fuscus) wintering in the Community of Madrid; just one individual... But in the winter of 2005/6, there were 22,603 Lesser Black-backed Gulls in the Community of Madrid (Cantos 2006). However, with the advent of GPS tracking and in contrast to Galván *et al.* (2003) suggesting that rivers played the major role in guiding gulls inland (e.g. following the Tagus and Guadiana), we have since learned that whilst the majority of Lesser Black-backed Gulls do follow coasts and rivers (Rock 2002), many cross land

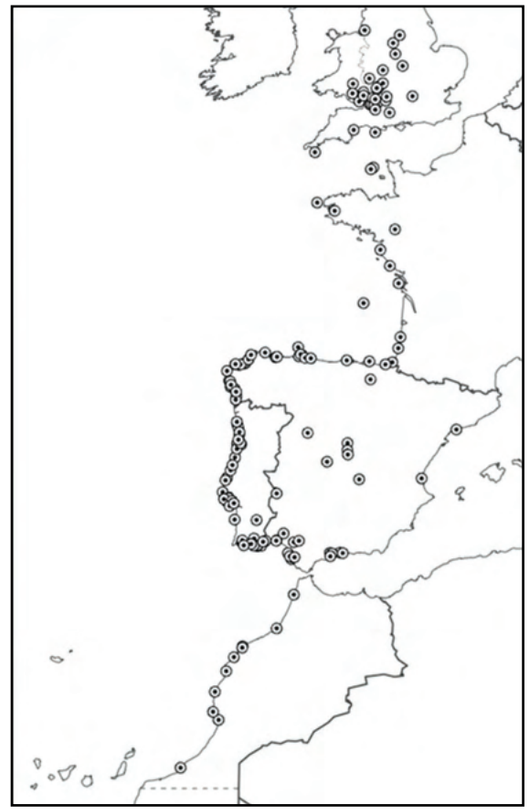


Figure 4. Recovery locations of Cardiff-ringed Lesser Black-backed Gulls between 2003-2021

masses regularly without relying on such visual clues, particularly in Iberia (e.g. Pütz *et al.* 2008, Ross-Smith 2013, Shamoun-Baranes 2017, etc.) and, possibly, many cross the Sahara Desert, too (Schmaljohann 2008).

Baker (1980) proposed that young Lesser Black-backed Gulls explore widely on migration, building up a familiar area far larger than that they will use when adult before crystallising out suitable wintering and breeding areas (the Exploratory Migration Model).

Plate 1. Blue3 G:J (Cardiff 6th May 2017), a female, ringed as a nestling in Bristol 3rd July 2004, breeding in Butetown, Cardiff (demonstrating the principle that females emigrate away from their natal colonies).

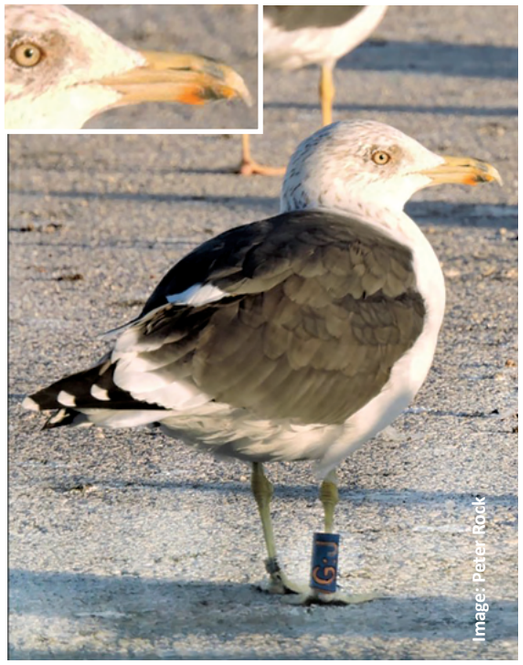


Plate 2. Blue3 G:J (Gafanha da Nazaré 20th November 2017).

In more than 50 expeditions to Portugal specifically to identify colour-ringed individuals, it has become clear that certain individuals do, indeed, follow the Exploratory Migration Model. Whenever I visit particular locations, I expect to find specific birds. Blue3 G:J is one such (plates 1 and 2). She began wintering within 25km of Aveiro, central Portugal, at the beaches, landfills and fishing ports when she was four years old. I have seen her several times at Gafanha da Nazaré over the last 10 years, including November 2021. Note that she has dark marks on her bill (neither staining nor dirt). Dark markings on the bill are not necessarily a character of youth. At the time of this photograph she was nine years old (the oldest Bristol Scheme Lesser Black-backed Gull, currently, is 27 years old and has dark marks on the bill every winter). Note, too, that she had no dark marks on her bill when she was photographed in Cardiff only six months before.

Of 269 Cardiff individuals with post-fledging records, 196 (72.9%) have been seen abroad at 118 locations. Figure 3 shows eight inland locations 100km or more from the coast in Iberia involving 20 individuals (i.e. 10.2% of those seen abroad); an apparently small number. Apart from Madrid city centre, all of these locations are landfills which often support large numbers of gulls in autumn and

winter (various observers *pers. comm.*) and which strongly suggests a bias towards observer effort.

During migration Lesser Black-backed Gulls often move quickly from one location to another and, if conditions are suitable, will linger before moving on (e.g. Rock 2002) which, from a colour-ringing dataset, makes precise determining how quickly they are moving (i.e. actual dates of arrival and departure do not necessarily coincide with observations). The fastest birds from the Bristol Scheme dataset move at anything up to 300km per day, but mostly rather less (*pers. obs.*), whereas The Bristol University GPS project reveals speeds (including flying at night) of over 600km per 24 hours (UvA-BiTS 2016) and, in short bursts, of 28.4m/s = 63mph. The Bristol University dataset also reveals that different routes were often chosen to and from their wintering destinations (Rock, *in prep*). There is no reason to suppose that Cardiff's Lesser Black-backed Gulls' migratory behaviour differs from others, but without concrete evidence it is difficult to be sure.

Of 2,172 post-fledging records of Cardiff-ringed birds by 327 observers, 734 were foreign observations, 453 were UK observations away from Cardiff and 985 were observations from Cardiff. Away from Cardiff, 16 adults (see table 5) have been observed during the breeding season (April to mid-July) in other urban colonies, or very near, with significant numbers of congruent records.

Herring Gulls

Traditionally thought of as sedentary, save for movements associated with bad weather (Tinbergen 1953), the Herring Gull was subsequently thought of as dispersive (Calladine 2002) with median movements from breeding/

Table 4. Countries where Cardiff-ringed Lesser Black-backed Gulls have been observed. Note: some individuals have been seen in more than one country. Indivs = Individuals, RpI = Records per individual.

Country	Indivs	Records	Rpk
France	12	24	2.00
Guernsey	1	2	2.00
Morocco	21	48	2.29
Portugal	110	295	2.68
Spain	90	365	4.06
Total/means	**234**	**734**	**x̄ = 3.14**

natal areas of 45.5km for adults and 88km for immatures. Latterly, those adult Herring Gulls moving greater distances are seen as migratory during the non-breeding season and though some of the individuals studied using GPS in southwest Scotland and northwest England stayed within the area of the breeding colony, the majority migrated southwards (O'Hanlon *et al.* 2022).

Of 51 Cardiff Herring Gulls with post-fledging records, 10 (19.6%) have moved further than 100km, three of which have made two such movements, but with such a small sample and a smaller amount of winter data for adults breeding in Cardiff, it is, unfortunately, impossible to compare. The furthest movement, so far, has been 417km to Île aux Moutons, Brittany (Figure 4). All but one of these birds were immatures. The one adult (a male) probably breeds in Cardiff (one record at Lamby Way during the breeding season), but between the ages of 6 and 9 has wintered in Wiltshire and Oxfordshire (87-135km from Cardiff) at landfills.

The Herring Gull was seen as coastal breeding bird in the 1950's and before (Tinbergen 1953) and, very likely, until the onset of urban breeding in the 1970's and the rapid expansion of urban breeding which occurred during the mid-1980's and 1990's saw increases in inland breeding (Rock 2005b). Figure 4 shows 36 recovery locations where Cardiff's Herring Gulls have been observed, 16 of which are strictly coastal and 20 are inland, but note the cluster of recovery locations along the River Severn where, at low tide, there are several roosting sites on exposed sand or mud where 200+ individuals of both species can frequently gather. Of the 20 inland locations, nine are landfills or waste transfer stations, underscoring the importance of landfills for the species (Pons 1992).

Immigration and Emigration

Colour-ringing offers the opportunity to investigate recruitment into breeding colonies; namely, the exchange between colonies of first-time breeders (once they are old enough to breed), or of established breeders which have been displaced. Bristol Scheme Herring and Lesser Black-backed Gulls, all of which are ringed as nestlings on rooftops (i.e. urban gulls), are frequently to be found in urban colonies other than their natal colonies. However, less than 0.1% of Bristol Scheme birds of breeding age have been observed in rural colonies such as Flat Holm or Steep Holm (see fig.

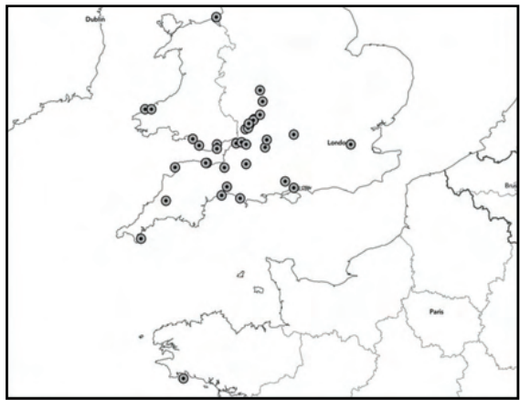


Figure 5. Recovery locations of Cardiff-ringed Herring Gulls between 2003-2021

2) at the right time of year (Rock 2005b). Despite the fact that the two islands are very close not only to Cardiff (11/15km), but also to other Bristol Scheme study colonies (Barry, Bridgend, Hinkley Point, Burnham-on-Sea) within about 40km, all of which, incidentally, have, or continue to support Bristol-ringed birds. Further, many of the Severn Estuary's urban colonies have had Bristol Scheme birds recorded as breeding within their populations (*pers. obs.*). In effect, then, it is common for urban gulls to recruit into other urban colonies, but rare in the extreme for gulls hatched in town to recruit into non-urban areas.

There have been 141 observations in Cardiff of 72 Bristol Scheme individuals originating from other colonies with 30 identified as likely breeders (i.e. adult birds seen during late-April to early July) of which 15 are confirmed breeders (i.e. seen incubating, at close attendance to incubating partner, pair-bonding, feeding or brooding nestlings). Curiously, all but one (from Barry) were from Bristol. Of 2,172 post-fledging records of Cardiff-ringed birds, reported by 327 observers, 985 were from Cardiff, 734 were from abroad and 453 were from UK locations away from Cardiff. Nine individuals have been confirmed as breeding in six colonies.

Flat Holm-ringed birds (which are also ringed as nestlings) have also been recorded in Cardiff in the breeding season during surveys, but of the nine, individually-coded colour-ringed birds only five Lesser Black-backed Gulls have been confirmed as breeders (Rock 2011, 2017). Intriguingly, one Lesser Black-backed Gull, ringed as a nestling on Tarnbrook Fell (Lancashire), a rural colony some 284km from Cardiff was confirmed as breeding in 2004 (Rock 2011): a total, therefore, of six rural-hatched birds supporting the notion that whilst it is extremely rare for urban gulls to recruit into rural colonies, the same appears to be true the other way around. Clearly, with only six surveys in the last 19 years, the numbers of rural-hatched individuals confirmed as breeders could well be an underestimate, but this also applies to urban-hatched individuals.

Many colour-ringed gulls from various schemes are recorded in Cardiff at all times of the year, but mostly between autumn and early spring (various observers *pers. comm.*) and particularly where feeding opportunities present themselves. The out of season visitors include individuals of known age and origin from the Bristol Scheme, Flat Holm and, of course, Cardiff and are often juveniles or immatures. Some visitors include individuals trapped and ringed at landfills whose origins are entirely unknown and whose ages are also often in doubt. These birds will have had to fly to landfills before being trapped and, moreover, whilst juveniles and immatures are readily identifiable, those birds beyond their fourth winter are impossible to age.

Birds of unknown origin have also bred in Cardiff, the majority of which (12) having been ringed at Gloucester and Stoke Orchard landfills under the auspices of the Severn Estuary Gull Group (SEGG) and one Lesser Black-backed Gull ringed at Chouet Landfill, Guernsey (P. Veron *pers. comm.*). With no clues about origins, it is plausible that they were already Cardiff breeders when trapped and ringed, or urban-hatched in Cardiff or elsewhere and later recruited into the Cardiff population.

It is suspected that Cardiff-hatched birds (and some carrying colour-rings) are very likely to have recruited into the many urban colonies that surround the city. Similarly, birds hatched in these colonies should also be recruiting into the Cardiff population (viz. the bird from Barry). At 42km distant, Bristol has been a major supplier of recruits into the Cardiff population (and other urban colonies in the region), but considerably more birds have been colour-ringed in Bristol than in all of the other colonies attached to the Bristol Scheme put together.

Discussion

Urban gulls have, for many years, been viewed as

Table 5. Cardiff-ringed gulls recruiting into other colonies and Bristol Scheme gulls recruiting into the Cardiff colony. Conf = Confirmed breeding individuals; Poss = Possible breeders; DfC = Distance from Cardiff.

	Cardiff-ringed birds emigrating				Non-Cardiff-ringed birds immigrating		
Colony	**Conf**	**Poss**	**Total**	**DfC**	**Conf**	**Poss**	**Total**
Bath	1	2	3	59		2	2
Barry	-	-		8	1		1
Bristol	2	4	6	42	14	13	27
Gloucester	2	1	3	77	-	-	-
Hereford	1	-	1	72	-	-	-
Newport	2	-	2	18	-	-	-
Sharpness	1	-	1	56	-	-	-
Total	**9**	**7**	**16**	**x̄=41.5**	**15**	**15**	**30**

problematic. Myriad complaints to local authorities have resulted in escalation to parliamentary level: in the first instance, in Scotland as long ago as 2002 (Scottish Parliament 2002) and later in Westminster (Hansard 2009, 2010, 2011, 2017, etc.). These debates, in turn, led to vilification in the media (e.g. Daily Star 12/3/2020 – "psycho gulls set free to run riot"). Pest control, with a range of techniques and equipment, was believed by many to offer solutions. However, much of what was on offer was ineffective, some of which bordered on the bizarre. Egg-replacement/oiling, as an example, can prevent hatching, but persistent breeding failure can result in pairs divorcing (e.g. Catry *et al.* 1997). Divorced pairs will, needless to say, find other partners and some will move away from their chosen territory or colony. This has been demonstrated by Moon (2009) using egg-replacement where circa 25% of pairs moved out of the (small) treated area, but that numbers increased in surrounding areas. In short, this technique has no effect at the population level and simply moves the problems around. The perceived problems are noise, mess and aggression, in that order (Rock 2005b). Nuisance has never been a reason for pest control, but under the General Licence it was possible for all and sundry to take action against gulls, including lethal action, without any regulation and without the need to report on action taken; in other words, it was open to abuse – a free-for-all (*pers. obs.*).

Gulls have been removed from the general licences issued by both Natural Resources Wales (NRW) and Natural England (NE); the two statutory nature conservation bodies that cover the Welsh and English sides of Severn Estuary, respectively. A specific licence to control gulls is now needed, with both NRW and NE requiring a management plan (Natural England 2021, Natural Resources Wales 2020) which necessitates justification for any lethal action (for example removal and destruction of nests, eggs, and nestlings) based solely on threats to human health and safety and where nuisance alone is excluded. The paperwork required is scrutinised carefully by the relevant statutory body but has been seen by some as time-consuming (and, thus, expensive) and has been opposed by several councils.

Herring and Lesser Black-backed Gulls, almost invariably, lay three eggs (Cramp and Simmons 1983) and, in town, are often able to raise three nestlings to fledging (Rock 2005b). However, survival to adulthood (i.e. fourth summer) is precarious and Bristol Scheme data show that only 45-55% (depending upon the cohort) will make it to adulthood (unpubl. data). Thereafter, barring accident, many will have breeding careers of up to 10 years, some will breed for 15 years and a few will breed for 20 years plus (unpubl. data). The oldest Bristol Scheme bird, presently, is in her 28th Calendar Year.

Furthermore, of the 117 colonies known about in the Severn Estuary Region, 47 (40%) have been assessed (*pers. obs.*) accounting for 22,000 pairs (range = 5-3,147 pairs, average = 468 pairs). Some colonies need reassessment (the last having been made more than 10 years ago), but of the remaining 70 unassessed colonies, some are known to be large (e.g. Port Talbot, Swansea) or very large (*viz.* Birmingham). A conservative estimate for the population of the region of 25,000 pairs breeding on rooftops allows some very simple,

but parsimonious calculations. Erring on the side of caution: 25,000 pairs = 50,000 eggs per year, of which, perhaps 30,000 will fledge and of these, 15,000 may survive to breeding age and circa half may recruit into their natal colonies and half to others in the region, or even out of the region as has already happened with Bristol Scheme birds from other colonies. Coupled with adult survival rates of around 90-95% (Rock and Vaughan 2013), the success of urban gulls is easy to see.

Cardiff's maximum recruitment distance (table 5), so far, is 77km which encompasses the majority of the colonies shown in figure 2. The maximum Bristol Scheme recruitment distance is 344km (to Brittany) with several over 100km and out of the region (e.g. London (3), Folkestone, Southampton, Falmouth, etc.). This is not a local issue, but a regional one and, very likely, a national one.

Knowing that urban-hatched gulls will not recruit into rural colonies, the idea that they can be 'driven back to the wild', as has been suggested by some, simply would not work. And knowing, too, that all urban colonies have been and will continue to provide recruits into other urban populations, the complexity of the urban gull issue is exposed. It is imperative, therefore, to understand the issue fully, followed up by pragmatic discussion (once all parties are informed) before investing in any precipitate action that may be interpreted as injudicious or even intemperate. Investigating other colonies in the region during the breeding season (and, if possible, ringing) would go some considerable way towards gaining a clearer picture of the dynamics of recruitment between colonies. Additionally, deploying GPS trackers would uncover a wealth of information about how, precisely, Cardiff's gulls live their lives.

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Short Communication

Curlew in Montgomeryshire

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Key words: Numenius arquata, population, conservation, Gylfinir Cymru

Abstract
The history and status of Curlew in Montgomeryshire is reviewed. The eastern half of the county held 176 pairs in 1986 but by 2000 only 42 pairs at 30 sites were identified. The story is brought up to date with the results of a survey in 2021 locating a total of 45 potential breeding pairs of Curlew in the county.

Introduction and History
Eurasian Curlew (Numenius arquata) are found throughout the year in Wales, frequenting coastal and some farmland areas in winter, and breeding on upland grassland and moorland and in lowland grasslands (Pritchard et al. 2021). The Curlew is listed as globally Near-Threatened on the IUCN Red List of Threatened Species and is a Red-listed Bird of Conservation Concern in both Wales and the UK. Curlew are also listed as being of Principle Importance for the Purpose of Conserving Biological Diversity under Section 7 of the Environment (Wales) Act 2016. Formerly widespread across Wales, breeding Curlew is now undergoing a sustained and chronic decline in both numbers and range. Breeding population estimates are from 400 to no more than 1,700 breeding pairs and is declining at a rate of 6% per year (Gylfinir Cymru 2021).

Mongomeryshire has long been known as a stronghold for breeding curlew where they are found in a wide variety of habitats, from moorlands to lowland silage fields. A review of the history of this species in the County is given by Holt and Williams (2008). In summary, Forest (1907) gave the North Wales (including Montgomeryshire) status as 'resident and common, breeding on all the moorlands and some lowland bogs'. Forest also noted that in the County, and along the English Border, curlew were tending to descend from the moors to lower habitats. This trend was noted by other authors, such as Condry (1966) who observed evidence that more birds were breeding on lower ground at that time than earlier in the 20th century, and fewer on the hills. There appears to have been general decline in Wales from the 1950's onward and Lovegrove et al (1994) concluded that while the Curlew was still "common and widespread" in Wales, the trend in the three decades to 1990 had been one of decline and diminution of range. Although a survey in 1986 (Mcfadzean and Tyler 1987) found 176 pairs in the eastern half of the County, by 2000 a survey found only 42 pairs at 30 sites across the County (Hughes, 2000, quoted in Holt and Williams 2008). This drastic decline was confirmed by Johnstone et al (2007) who showed a 69% decline in the County between 1993 and 2006. Further surveys at specific, mainly upland, sites in the mid 2000's driven by proposed windfarm developments confirmed this trend as shown by Green (2012) who summarised sites where repeat surveys had been undertaken (table 1)

Table 1. Declines in Curlew at three sites in Montgomeryshire (from Green 2012)

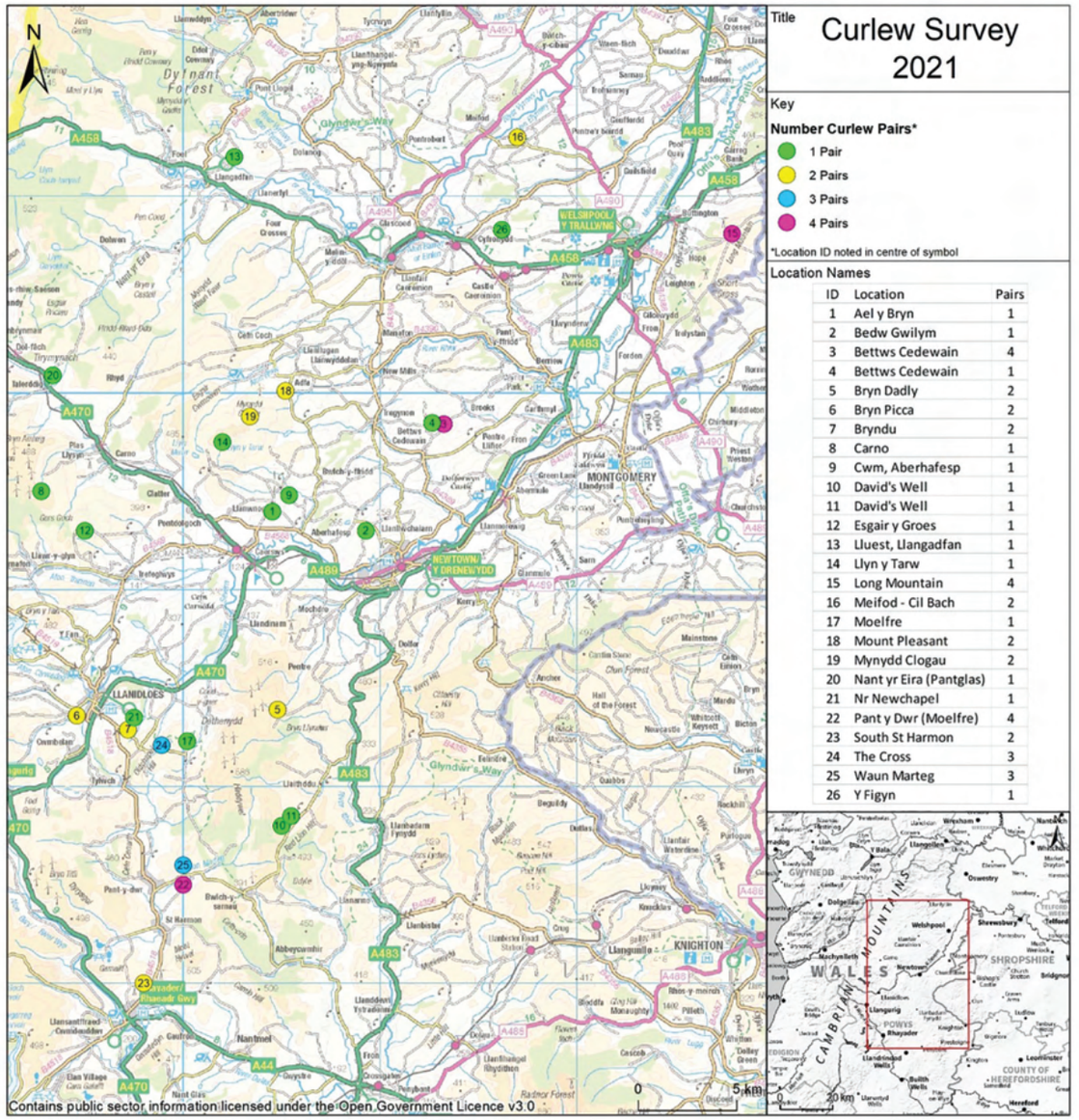
Size	Date of prev survey	Pairs	Pairs 2012
Trannon	1995	13	1-2
Mynydd yr Hendre	2005	5-6	1-2
Nant yr Eira	2006	10	2

Although these declines have been dire, overall Montgomeryshire remains important in a Welsh context and it has been identified as an 'Important Curlew Area' (ICA) in the Wales Action Plan for the Recovery of Curlew (Gylfinir Cymru, 2021). The County also has interesting numbers of wintering and passage flocks such as on the Severn near Caersws and at Dolydd Hafren. The maximum counts at the latter were between 50 and 100 between 2016 and 2019 (Montgomeryshire Bird Reports 2016, 2018 and 2019).
2021 survey and the Important Curlew Area

In 2021 a wider survey was attempted to try and update our knowledge of the curlew population in this area and help define the boundaries of an 'Important Curlew Area' as part of the Wales Recovery Plan (Gylfinir Cymru 2021).

Methods
No formal survey method was employed, and surveys were undertaken from roads, public rights of way and open access land. This was due to the limited time and funding. Birds were recorded where seen or heard and surveyors expertise used to decide on the potential number of breeding pairs in any area. A tape of curlew calls was used to elicit responses at some sites. No effort was made to locate nests or look at productivity due to lack of time and funding and to avoid disturbing birds. Areas known from previous surveys, sites where we had received records and, where time allowed, other areas of potential habitat, were all visited at least twice during the breeding season between March and June 2021. More lowland areas were

Figure 1. Results of the 2021 Curlew survey.



covered than in other recent surveys as these had concentrated on upland windfarm areas.

Results

A total of 45 potential breeding pairs were located in this survey. The results, and the survey area (which included part of North Radnorshire) are shown in Figure 1. A further three pairs, not shown on the map, were found in the Churchstoke area by the Camlad Valley Community Wildlife Group (L Smith, *pers. comm.*) The results show a broad spread of Curlew across the area and birds were found in a wide variety of habitats, from upland moorland, through grazed pasture down to intensive silage fields.

Upland pairs, found during previous windfarm related surveys and shown in Table 1, had declined considerably. For example, in Nant y Eira, heading North from Talerddig no pairs were found. This valley contained 11 pairs in 2005. A windfarm at Mynydd y Hendre, north of Carno, held no birds having previously holding up to five pairs. This is despite extensive habitat management done as part of the development. The site at Trannon held no birds either, although there was an early record of calling birds there in 2020. No comparison was available for the lowland sites.

Discussion

The results confirm that Montgomeryshire (and North Radnorshire), despite declines, continues to be an important area for Curlew that should be targeted for curlew conservation funding. It is unclear why the upland pairs seem to have declined but it may be that we just have more recent surveys from these sites than the lowland ones which, while still well distributed, may have declined just as much. From those sites for which we have historical records it is clear that there is a long-term decline in the areas Curlew population, although it retains a significant and important population. The numbers found justify the areas designation as an 'Important Curlew Area' and the population here is contiguous with pairs found across the border in Shropshire which are the subject of a separate conservation project (Gylfinir Cymru 2021). Conservation efforts are urgently required to save this important population and will require continued cross-border co-operation.

Acknowledgments.

The survey was initially funded by the Ecology Matters Trust, with added funding for analysis and write up provided by NRW. Montgomery Wildlife Trust were project partners and I am very grateful to all their members who sent in records. The Welsh Ornithological Society asked their members for records across Wales and several were received for this area. Tony Cross also contributed time to the survey. Crona Hodges, Geosmartdecisions Ltd, kindly produced the map.

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Forum

Released pheasants and invertebrates - a discussion of Devlin et al. (2021)

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Key words: Gamebirds, shooting, ecological impacts, evidence

Abstract

Releasing pheasants and partridges for shooting has a mixture of ecological effects, some of which are positive, usually habitat management activities, while others are negative. Release sites in particular are a focus for negative effects including degradation of ground floras and changes to invertebrate communities inside release pens. There is no direct evidence that released or wild gamebirds affect floras or invertebrates away from release or feed areas. A recent paper in Birds in Wales (Devlin *et al.* 2021) however, describes a field study that reports an association between invertebrate abundance and pheasant activity away from release sites. Despite initial appearances however, the study breaks the basic rules of a robust field study, with no randomisation of treatment, no replication of treatment and ineffective treatment. With just two plots, it has little power to investigate relationships between insects and pheasants and its conclusions are unsupported. The science around this issue so far provides no direct evidence of an effect of pheasants on insect populations or communities in the wider countryside. However on this and other issues related to non-native gamebirds and releasing, what is required is a well-informed debate backed up where possible with good quality science.

Main text

Releasing pheasants for shooting has a range of ecological consequences. Research has shown that negative effects tend to be caused by the birds themselves while positive effects are usually a consequence of woodland or farmland management activities for game. For a peer-reviewed summary review of ecological consequences of releasing see Sage *et al.* (2020), see also Madden & Sage (2020), Mason *et al.* (2020).

These reviews tell us that release sites are a focus for direct negative effects and there have been several studies which indicate that soils, flora and invertebrate communities can be affected in woodland pens and sometimes adjacent to those pens (e.g. Sage *et al.* 2005, Neumann *et al.* 2015). It is likely those effects also occur at feed points or alongside game crops on farmland. There are guidelines designed to minimise or eliminate some of these unwanted effects, especially in woodland (Sage *et al.* 2021).

There is no direct evidence that released or wild gamebirds affect invertebrates away from areas where birds congregate despite efforts to investigate this e.g. Callegari (2006) and Pressland (2009) (which is sometimes cited to suggest there is, but see Sage *et al.* 2020 for a summary of the actual findings of that PhD thesis).

However, according to a paper published in the last edition of Birds in Wales (Devlin *et al.* 2021), a study was undertaken by Cardiff University on pheasants and invertebrates in Wales which '…tests for impacts of pheasants on invertebrate communities beyond the boundaries of land managed for pheasant shooting….' and (the headline result) '….observed a negative association between pheasant activity and overall invertebrate abundance….'

In summary, the study site was an area of rough grass in a field three kilometres from a 'small scale' pheasant shoot. Data were collected over a 16-week period in spring / summer 2019. In the field, two 25x25m plots (called quadrats in the paper) were marked out and one was fenced with chicken wire. This was the 'control' plot and discouraged access by pheasants (and other animals). Various vegetation characteristics were measured and invertebrates sampled from each plot in several quadrats. This was done each week for 16 weeks. Trail cameras recorded pheasants in the plots.

The sample size for this study is two plots (quadrats), one with a fence, one without. How these two plots

were located on the site is not described. Because of any number of site-related factors, one plot would probably have to some extent different vegetation and invertebrate characteristics than the other. The invertebrates (and vegetation) were then sampled each week. This is sometimes called repeated measures. The five wooden blocks beneath which invertebrates were counted within each plot do not add to sample size; they measure the same thing and simply improve the accuracy of the estimate. Note also that key herbivores like rabbits as well as pheasants would have been excluded from the fenced plots.

Key elements of the data analysis are not entirely clear. There is no statement of what constitutes the unit for analysis, or of effective sample sizes. A consequence of this is that samples from e.g. blocks or squares within quadrat should have been aggregated or summarised at the visit level. Whether this was done and, if so, how, is not described. It is also not clear whether the data from the two quadrats were analysed in the same model or in separate models. There is also the potential issue of multiple testing (with various insect groups being analysed) which is not mentioned.

As long as the analysis either considered the data from each quadrat separately, or did a joint analysis with quadrat as a factor in the model, then the longitudinal analysis approach taken is appropriate. However, the interpretation of this analysis assumes independence between weekly visits. Central to the results is the test of the pheasant x quadrat interaction, which is interpreted as a comparison of treatment versus control. The terms treatment and control are also used when comparing results from each quadrat. Because of the lack of replication, treatment/control effects are confounded with plot effects. Any observed differences may therefore arise simply from the choice of quadrat location rather than whether a quadrat was enclosed or not, or from primary/secondary effects of treatment, or from a mix of both – it is impossible to say. There is no mention of the issue of confounding or of interpretational difficulties in the Discussion.

While there is a perception that released pheasants are reducing invertebrate populations in the wider countryside, there is no direct evidence from any sources that this happens to any significant extent (Sage *et al.* 2021). Is it plausible? Unlike chicks, adult pheasants do not need a high protein-based diet (Beer 1988) and their food intake is primarily plant based (Robertson 1997). However released pheasants have been found to affect invertebrates inside and close to release pens, when densities are high and vegetation sometimes depleted, probably due to a combination of pecking and micro-habitat changes (Sage *et al.* 2020). Inside these pens typical densities of 1000 birds per hectare are usual (Sage *et al.* 2021) and can be similar very close to those pens. As pheasants disperse these densities dwindle rapidly with, typically, no more than a few birds per hectare at 1km or so from the release pen (Sage *et al.* 2021). Wild pheasants probably eat more insects than released pheasants (Jensen *et al.* 2012) but they are far less common in the UK countryside than released birds and most of Wales provides especially poor habitat for breeding pheasants (Tapper 1999). While no data are presented on this in the paper, with releases within a few km (Figure 1) it is unlikely this study recorded mainly wild birds in the plots.

Devlin *et al.* (2021) uses phrases like 'Preliminary investigation…' and 'Limited by pheasant numbers and replication….' which acknowledges to some extent its lack of power. But this is still misleading because it breaks the rules of a robust field study, preliminary or otherwise, with no randomisation of treatment, no replication of treatment and ineffective treatment. It has little statistical power, there is no scope for allocating the key treatment effects relating to pheasants and the measurements taken and arrives at some unsupported conclusions.

Releasing pheasants and partridges for shooting in Wales, England and Scotland is not always popular. It has a mixture of ecological effects, some of which are clearly negative, and people object to it on ethical grounds or feel that it has unwanted social implications. Others feel it has good social effects, is a major contributor to rural economics in many places and encourages good habitat management activity, especially on farmland that is otherwise often very degraded in terms of habitat quality. There are UK government licencing arrangements (GL43) for releasing near to designated sites in place in England, which will be reviewed in two or three years time. What is required in the meantime is a well-informed debate, with good quality science properly documenting the ecological consequences of releasing for shooting.

Acknowledgements
Dr Nicholas Aebischer provided statistical advice.

Milvus 1:1 (2022) A Discussion of Devlin *et al.* (2021)

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Image: Steve Slater

Forum

A Response to R. Sage

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Key words: Gamebirds, shooting, ecological impacts, evidence

Rufus Sage's somewhat intemperate response to our recent paper (Devlin, Jones & Thomas 2021) raises several interesting and surprisingly revealing points, which we address in this reply.

1. Sage complains that we have presented our results as "definitive", thereby implying that we have deliberately attempted to mislead the journal's readership. We find this statement very surprising because the title of our paper begins with the words "Preliminary Observations of…". We are not sure how we could have made the preliminary nature of our study and its findings any more explicit to readers from the outset, and indeed throughout the paper. For example, as Sage himself admits, our abstract ends with the following sentence: "Limited by pheasant numbers and replication, we present this preliminary work as a template on which further studies on the quantification of the impacts of pheasants on invertebrate communities may be based."

2. Sage complains that "Key elements of the data analysis are not entirely clear. There is no statement of what constitutes the unit for analysis, or of effective sample sizes", yet he goes on to set out exactly these points using the information that we present in our Methods section. Does this, in itself, not confirm that the description of our study (including its limitations in terms of replication) is indeed perfectly evident and explicitly described in our paper. Furthermore, Sage's statement that "the study breaks the basic rules of a robust field study, with no randomisation of treatment, no replication of treatment and ineffective treatment" raises an important point that is discussed in some detail by Davies and Gray (2015). In the case of studies with limited replication, particularly those with restricted budgets, Davies and Gray suggest that authors should show honesty regarding replication, and caution regarding the extent in which causation is ascribed to results. This is explicitly the approach we have taken in this manuscript, and we openly invite others to replicate our methods to provide further data. Additionally, again following Davies and Gray (2015), we used statistical approaches to account for these replication issues. Specifically, we used a Generalised Additive Model with the smoothed independent variable 'week' to model explicitly changes over time in both invertebrate abundance and diversity within the study plots (following Thomas et al. 2017).

3. Sage claims that the "treatment" of excluding pheasants using fencing is ineffective, yet we show that the frequency of pheasant detections on camera traps is substantially lower inside the exclusion fence than outside (18 vs. 141 camera trap detections across the 16 weeks of the study: Table 2). Sage mentions that rabbits would have been excluded from the fenced quadrats, but the very few observations of rabbits in our study (n = 4 camera trap images) all occurred within the fenced treatment quadrat itself (data not included in the original paper in order to meet word limits), likely due to rabbits digging under the fence.

4. Sage, based in the south of England, appears to believe that abundance of pheasants must be inversely proportional to the distance from the nearest shoot, yet he does not present any data to support that this opinion applies to the Welsh landscape that we study. Our data show that at the study site pheasant density is high (141 camera trap detections in a 25 x 25m open (unfenced) quadrat across 16 weeks), despite it being located ~3 Km from the nearest commercial shoot. Indeed, it would be very surprising to us if pheasant density was simply inversely proportional to the distance from a release point (e.g. ~ 1/distance2), because some habitats (e.g. the diverse grassland in our study quadrats) are likely to be more attractive to pheasants than others (e.g. the relatively species poor pasture in much of the surrounding farmland), and so we would expect aggregation of pheasants in the most suitable habitats.

5. Sage states that "positive effects [of mass gamebird releases] are usually a consequence of woodland or farmland management activities for game". This is undoubtedly true in some circumstances, yet Sage fails to address the widespread concerns that mass releases of tens of millions of pheasants each year result in high densities of pheasants in habitats that are not (and have never been) managed for game. It is the impact of these "spill-over" effects into potentially highly sensitive habitats that we address in our paper.

6. Sage requests information about the location of the two quadrats in relation to each other. We confirm that the two quadrats were immediately adjacent to each other, in the location shown in Figure 1. We agree with Sage regarding the possible "different vegetation and invertebrate characteristics" between quadrats. Our statistical approach (as outlined in Table 1) was chosen to describe and control for these observed differences.

7. Sage appears to be concerned about whether the pheasants in our study quadrats are captive-bred or "wild". Such a distinction is obviously impossible to make using camera trap images, but our understanding of the local pheasant shoots is that the vast majority of pheasants in the area are predator-naïve, captive bred livestock that are simply released in large numbers each autumn at the shoot locations.

8. Sage suggests that "It is also not clear whether the data from the two quadrats were analysed in the same model or in separate models." Data from the two quadrats were indeed analysed in the same models, as is made explicit in Table 2, where "quadrat" is listed as an independent variable. Again, we are not sure how this could be made any more explicit in our paper.

Unfortunately, in criticising this preliminary study, Sage has failed to address in detail the deep ethical, ecological and economic concerns surrounding the legal and illegal activities of game-bird shooters within Wales and other countries within the UK. We urge Sage in particular, and the Game and Wildlife Conservation Trust (GWCT) in general, to engage meaningfully with the mainstream conservation community within Wales, for example by presenting their own data (if such data exist) on the ecological impacts of mass gamebird releases and gamebird shooting businesses within Wales, for open scrutiny and discussion at a meeting of the Welsh Ornithological Society.

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Summary of Guidelines for Authors

Assistance with producing an article

Writing an article can be a daunting prospect, even if you have an idea for a piece that you think people would find interesting, or would provide useful information. Perhaps you have never written an article before. Perhaps you don't know where to get data or find information. Perhaps you know where to get information but don't have access. Perhaps you have data but aren't confident with how to analyse it. If that sounds like you then I offer some reassurance.

These guidelines exist to provide a framework and consistent standards across published articles. But if you find the specifics daunting, help is always available. You can reach out to the Editor or a member of the Editorial Board at any point to discuss your idea, ask for help with structure, content or resources, or to provide feedback.

The full guidelines provide detailed information on articles structure, referencing, elements (figures, tables and photographs) and are available online or can be obtained by emailing the Editor.

1. Preparation of manuscripts

The Editor is happy to advise on suitable topics and would welcome enquiries at an early stage. Please write in a readable style that avoids complications, jargon and pomposity. All papers will be reviewed by the Editor and at least one independent referee. Comments made by the referee will be passed on to the author(s) to consider whether any changes are required. If the referee and the author(s) disagree on any proposed changes, the Editor's decision will be final.

2. Manuscript submission

Papers are accepted and published in either Welsh or English. All articles should be submitted via the online system or emailed to the Editor. Papers should not have been submitted to any other journal. In accordance with standard international practice, papers in Welsh should be supplied with captions to tables and figures in both Welsh and English and with an English summary. A Welsh summary for English papers will be arranged by the Editor if the authors are unable to produce one.

3. Article types

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3.1. Original Research.

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These are limited to 2500 words, excluding references and figure legends, and no more than three display items (tables/figures). A Short Communication is suitable for brief reports of observations of interest including novel behaviour and species identification, notes on methods or equipment, or work based on small sample sizes.

3.3. Review.

A Review represents a comprehensive summary on a topic of relevance to Welsh birds and associated conservation, management and/or policy. Reviews are limited to 6000 words.

3.4. Forum.

A Forum Article is a concise discussion of a topic of relevance to Welsh birds. Forum Articles are limited to 3000 words and are not expected to be as comprehensively referenced as a Review. Forum Articles might focus on recent papers in Milvus or elsewhere, government policy, or a conservation need. They can also be factually-based (and fully referenced) opinion pieces.

4. Figures, tables and photographs

Table and figure legends should be included within the text file and contain sufficient information to be understood without reference to the text. Each should begin with a short title for the figure. All symbols and abbreviations should be explained with a key. Each figure and table should be placed on a separate page. All lettering and symbols must be clear and easy to read. Information should not be duplicated between tables and figures. All tables, figures and photographs should be cited in the main text as (table X), (fig. X), or (plate X).

5. Ethics

Authors of research papers submitted to Milvus are expected to act within the standards and procedures laid down by Welsh and UK legislation. They must ensure they have the necessary licences and permits for the activities described in the paper. Authors should consider the potential impacts of disturbance, trapping, and manipulations such as marking or tagging on their study animals and provide details in the paper on how these aspects have been dealt with. Papers will not be accepted if they are based on work involving cruelty to animals or if the work may have put at risk endangered populations, species or habitats.

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Milvus uses the Harvard system. This is in two parts, the names(s) of the author(s) and the year in the text, and the full details of the reference in an alphabetical reference list. A short summary is given here. Further details can be found on the web; for example the Cardiff University Harvard Referencing Tutorial at: https://dkit.ie.libguides.com/harvard/citing-referencing.

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